भारतीय मानक
Indian Standard

IS 15493 : 2021

गैसीय अग्नि शमन प्रणाली — सामान्य आवश्यकताएँ

(पहला पुनरीक्षण)

Gaseous Fire Extinguishing Systems — General Requirements

(First Revision)

ICS 13.220.10

© BIS 2021

भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDARDS
मानक भवन, 9 बहादुरशाह ज़फर मार्ग, नई दिल्ली – 110002
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI-110002
www.bis.gov.in www.standardsbis.in

March 2021 **Price Group 11**

Firefighting Sectional Committee, CED 22

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Firefighting Sectional Committee had been approved by the Civil Engineering Division Council.

As India is a signatory to the Montreal Protocol, the country programme was drafted earlier, wherein suitable alternative clean agents were identified in the place of halons 1301 and 1211. As per the approved programme, this standard was formulated for the identified alternatives. The agents covered in this standard were thus introduced in response to international restrictions on the production of certain halon fire extinguishing agents under the Protocol signed in 1992, as amended from time to time.

It is important that the fire protection of a building or plant be considered as a whole. Gaseous clean agent systems form only a part, though an important part, of the available facilities, but it should not be assumed that their adoption necessarily removes the need to consider supplementary measures, such as the provision of portable fire extinguishers or other mobile appliances for first aid or emergency use, or to deal with special hazards. Gaseous fire suppression systems covered in this standard are designed to provide a supply of gaseous extinguishing medium for the extinction of fire involving high value assets.

Gaseous clean agents have for many years been a recognized effective medium for the extinguishing of flammable liquid fires and fires in the presence of electrical and ordinary Class A hazards, but it should not be forgotten, in the planning of comprehensive schemes, that there may be hazards for which these media are not suitable, or that in certain circumstances or situations there may be dangers in their use requiring special precautions. These difficulties have been addressed in this standard.

Various methods of supplying clean agent to, and applying it at the required point of discharge for fire extinguishing were developed some time back, and there was a need for dissemination of information on established systems and methods. This standard was first published in 2004 to meet this need. Requirements to eliminate the need to release clean agents during testing and commissioning procedures were included in the standard. These were linked to the inclusion of enclosure integrity testing.

The requirements of this standard were made in the light of the best technical data available then despite the fact that a wide field was covered. It is assumed then that the execution of the provisions of the standard is entrusted to people appropriately qualified and experienced in the specification, design, installation, testing, approval, inspection, operation and maintenance of systems and equipment, for whose guidance it was prepared, and who can be expected to exercise a duty of care to avoid unnecessary release of clean agent.

Specific requirements and advice on these matters can be obtained from the appropriate manufacturer of the clean agent or the extinguishing system. Information may also be sought from the appropriate fire authority, the health and safety authorities and insurers. In addition, reference should be made as necessary to other statutory regulations. It is essential that fire equipment be carefully maintained to ensure instant readiness when required. Routine maintenance is liable to be overlooked or given insufficient attention by the owner of the system. The importance of maintenance cannot be too highly emphasized.

In this revision, the following major changes have been made:

a) New provision on description of the installation has been included.
b) Suitability and application of gaseous fire extinguishing system has been updated.
c) List of halocarbon agents and their properties have been updated.
d) New provisions on monitoring of gas extinguishing systems have been included.
e) Requirements of regular inspection towards effective functioning have been included.
f) Terminology has been updated.
g) All the cross-referred Indian Standards have been updated and the lists made comprehensive.

(*Continued to third cover*)

Indian Standard

GASEOUS FIRE EXTINGUISHING SYSTEMS — GENERAL REQUIREMENTS

(First Revision)

1 SCOPE

This standard specifies provisions and recommendations for general requirements, type of clean agents and their containers, container arrangement, distribution systems, such as piping, nozzles, pipe supports, alarm system, type of enclosure, etc.

NOTES

1 This standard covers the general requirements applicable to total flooding clean agent systems like halo-carbon agents and inert gas agents. In addition, individual requirements for each type of clean agent system are covered under separate standards, namely IS 15497, IS 15501, IS 15505, IS 15506, IS 15517, IS 15525, IS 15821 and IS 15835. Detailed design guidelines are specified in these standards. Hence, before designing a protection with a particular clean agent, both the standards should be read together. Wherever there is a difference, the individual standard takes precedence.

2 This standard prescribes minimum requirements for total flooding clean agent fire extinguishing systems. Protection with carbon dioxide is not covered in this standard for which IS 15528 may be referred.

2 REFERENCES

The standards listed in Annex A contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and the parties to agreements based on this standard are encouraged to apply the most recent editions of the standards indicated in Annex A.

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 7673, IS 8757 and the following shall apply.

3.1 Adjusted Minimum Design Quantity (AMDQ) — The minimum design quantity of agent that has been adjusted in consideration of design factors.

3.2 Approved — Acceptable to a relevant authority. In determining the capability of the installations, the authorities may base their acceptance with appropriate standards. The design and system approval shall be from national or international approving authority or laboratory of repute.

3.3 Authority — The organization, office or individual responsible for approving an installation or equipment or a procedure.

3.4 Automatic — Performing a function without the necessity of human intervention.

3.5 Automatic/Manual Switch — A means of converting the system from automatic to manual (manual override) and *vice-versa*.

3.6 Class A Fires — Fire in ordinary combustible materials, such as wood, cloth, paper, rubber, many plastics, electrical and electronic hazards without any flammable fluid or gas.

3.7 Class B Fires — Fire in flammable liquids, oils, greases, tars, oil-based paints, lacquers and the like.

3.8 Class C Fires — A fire that involves energized electrical equipment.

3.9 Clean Agent — Electrically non-conducting, vapourizing, or gaseous clean agent that does not leave a residue upon evaporation. The word agent wherever appearing in this standard shall mean clean agent unless otherwise indicated.

3.10 Clearance — The air distance between clean agent equipment, including piping and nozzles and unenclosed or uninsulated live electrical components at other than ground potential.

3.11 Containers — Cylinders or other vessels used to store the clean agent.

3.12 Container Discharge Valve — A valve directly connected to a container which when actuated releases the clean agent into the distribution piping.

3.13 Control Device — A device to control the sequence of events leading to the release of clean agent.

3.14 Concentration

3.14.1 *Design Concentration* — The concentration (including safety factor) of the clean agent necessary to extinguish a fire from a particular fuel.

3.14.2 *Adjusted Minimum Design Concentration (AMDC)* — The target minimum design concentration after the safety factor and the design factors have been taken into account.

3.14.3 *Final Design Concentration* (*FDC*) — The actual concentration of agent discharged into the enclosure.

3.14.4 *Extinguishing Concentration* — The concentration (without safety factor) of the agent necessary to extinguish a flame of a particular fuel at atmospheric pressure.

3.14.5 *Hazardous Concentration* — The concentration that exceeds the LOAEL (*see* **3.30**) for the agent used.

3.14.6 *Injected Concentration* — The concentration of the agent necessary to develop under free efflux conditions the required design concentration.

3.14.7 *Maximum Concentration* — The concentration achieved from the actual clean agent quantity at the maximum ambient temperature.

3.14.8 *Residual Oxygen Concentration* — The resulting concentration of oxygen achieved within a protected area after the discharge of agent into the area.

3.15 Design Factor (DF) — A fraction of the agent minimum design quantity (MDQ) added thereto deemed appropriate due to a specific feature of the protection application or design of the suppression system.

3.16 Directional Valve — A device for controlling the passage of the clean agent from a supply manifold and directed to pre-selected area(s) of protection (also known as selector valve).

3.17 Discharge Inhibit Switch — A manually operated switch that prevents the automatic discharge of the clean agent.

3.18 Distribution System — All the pipe work and fittings downstream of any container discharge valve.

3.19 Engineered Systems — A system requiring individual calculation and design to determine the flow rates, nozzle pressures, pipe size, area or volume protected by each nozzle, quantity of agent, and the number and types of nozzles and their placement in a specific system.

3.20 Fill Density — The mass of gaseous agent per unit volume of container expressed in kg/m^3.

3.21 Final Design Quantity (FDQ) — A quantity of agent determined from the agent minimum design quantity as adjusted to account for design factors and pressure adjustment.

3.22 Flooding Quantity — Mass or volume of clean agent required to achieve the design concentration within the protected volume within the specified discharge time.

3.23 Gross Volume — The volume enclosed by the building elements around the protected enclosure, less the volume of any permanent impermeable building elements within the enclosure.

3.24 Halocarbon Agent — An agent that contains as primary components one or more organic compounds containing one or more of the elements fluorine, chlorine, bromine, or iodine.

3.25 Holding Time — Period of time during which a concentration of clean agent greater than the fire extinguishing concentration surrounds the hazard.

3.26 Inert Gas Agent — An agent that contains as primary components one or more of the gases helium, neon, argon, or nitrogen. Inert gas agents that are blends of gases can also contain carbon dioxide as a secondary component.

3.27 Inerting — The prevention of re-ignition of a flammable or explosive atmosphere by establishing a suitable concentration of the clean agent.

3.28 Liquefied Gas — A gas or gas mixture (normally a halocarbon) which is liquid at the container pressurization level at room temperature (20 °C).

3.29 Lock-off Valve — A mechanically operated device which prevents a clean agent from being discharged through distribution pipe work to the protected area.

3.30 Lowest Observed Adverse Effect Level (LOAEL) — The lowest concentration of clean agent at which an adverse toxicological or physiological effect has been observed.

3.31 Maintenance — Thorough check, comprising a thorough examination and any necessary repair or replacement of system component, to give maximum assurance that the extinguishing system will operate as intended.

3.32 Manual — Requires a human intervention to accomplish a function or task.

3.33 Maximum Working Pressure — Equilibrium pressure within a cylinder at the maximum working temperature. For liquefied gases, this is at maximum fill density and may include super-pressurization, if applicable.

3.34 Minimum Design Quantity (MDQ) — The quantity of agent required to achieve the calculated minimum design concentration.

3.35 Monitoring — The supervision of the operating integrity of an electrical, mechanical, pneumatic or hydraulic control feature of a system.

3.36 No Observed Adverse Effect Level (NOAEL) — The highest concentration of a clean agent at which no adverse toxicological or physiological effect has been observed.

3.37 Non-liquefied Gas — Gas or gas mixture which, under reserve pressure and allowable reserve temperature conditions, is always present in a gaseous form.

3.38 Normally Occupied Area — An area where, under normal circumstances, humans are present.

3.39 Normally Unoccupied Area — Area not occupied by people but may be occasionally entered for brief periods.

3.40 Nominal Size — A numerical designation of size which is common to all components in a piping system other than components designated by outside diameters or by thread size. It is a convenient round number for reference purposes and is only loosely related to manufacturing dimensions.

3.41 Operating Device — Any component involved between actuation and release mechanisms.

3.42 Pre-engineered Systems — Those having pre-determined flow rates, nozzle pressures and quantities of clean agent. These systems have the specific pipe size, maximum and minimum pipe lengths, flexible hose specifications, number of fittings and number and types of nozzles prescribed by a testing laboratory.

NOTE — The hazards protected by these systems are specifically limited as to type and size by a testing laboratory based upon actual fire tests. Limitations on hazards that can be protected by these systems are contained in the manufacturer's installation manual, which is referenced as part of the listing.

3.43 Primary Release — Release of clean agent initiated by detection system or manual operation under normal operating conditions.

3.44 Release — The opening of the cylinder and directional valves leading to the physical discharge or emission of clean agent into the enclosure.

3.45 Safety Factor (SF) — A multiplier of the agent flame extinguishing or inerting concentration to determine the agent minimum design concentration.

3.46 Safety Interlock — A switch that monitors the occupation of the protected area and automatically inhibits the discharge of the clean agent when the area is occupied.

3.47 Sea Level Equivalent of Agent — The agent concentration (volume, percent) at sea level for which the partial pressure of agent matches the ambient partial pressure of agent at a given altitude.

3.48 Sea Level Equivalent of Oxygen — The oxygen concentration (volume, percent) at sea level for which the partial pressure of oxygen matches the ambient partial pressure of oxygen at a given altitude.

3.49 Secondary Release (Slave) — A release that is a consequence and dependent on the operation of the primary release, for example, pneumatic connection.

3.50 Super-pressurization — The addition of a gas to the clean agent container, where necessary, to achieve the required pressure for proper system operation.

3.51 Total Flooding — The act and manner of discharging an agent for the purpose of achieving a specified minimum agent concentration throughout a hazard volume.

3.52 Total Flooding Systems — A firefighting system that is arranged to discharge clean agent into an enclosed space to achieve the appropriate design concentration.

3.53 Unoccupiable Area — Area which cannot be occupied due to dimensional or other physical constraints (like shallow voids, cabinets, etc).

4 GENERAL INFORMATION

4.1 General Clauses

4.1.1 Extinguishing gases are three-dimensional agents that are used effectively to suppress fire through physical or chemical action. Separate properties of specific gases are provided in other parts of this standard.

4.1.2 Gaseous total flooding systems may be used to contain fires of classes A, B, C type as defined in **3.6** to **3.8**. However, for containing fires where flammable gases may be present, the possibility of explosion during and after system discharge should be considered.

4.1.3 Clean agent gas extinguishing systems are useful within the limits of this standard in extinguishing fires in specific hazards or equipment and in occupancies where an electrically non-conductive medium is essential or desirable, or where cleanup of other media poses a problem.

4.1.4 Where clean agent gas extinguishing systems are used, a fixed enclosure shall be provided about the hazard that is adequate to enable the specific concentration to be achieved and maintained for the specified period of time.

4.1.5 The effects of agent decomposition on fire protection effectiveness shall be considered when using clean agents in hazards with high temperatures (for example, furnaces and ovens, etc).

4.1.6 The design, installation, service and maintenance of the gas extinguishing systems shall be performed by those competent in the respective field in accordance with IS 15496.

4.1.7 The installer of the clean agent system shall be certified by a reputed national/international agency/laboratory and such certification shall be valid at the time of installation.

4.2 Description of the Installation

4.2.1 The schematic diagram shown in Fig. 1 illustrates the functional interaction between the components which shall (solid lines) or may (dotted lines) be present in an installation.

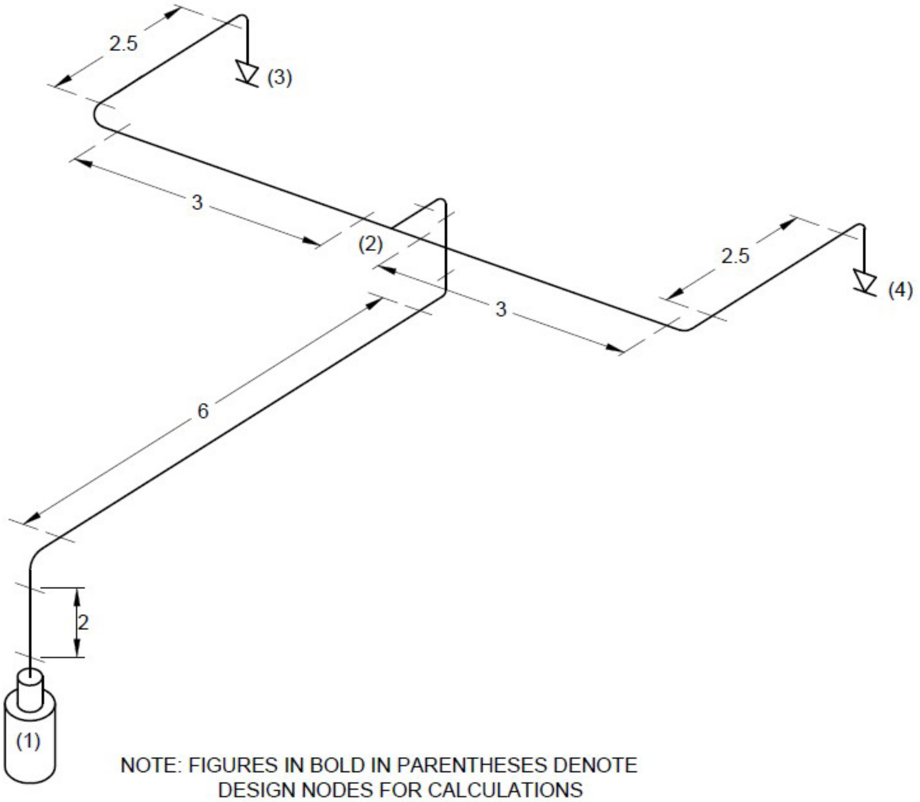
4.2.2 Halocarbon gas installations, in general, consist of gas containers, valves, fixed pipework with appropriately located nozzles in the protected zone and devices for detecting the fire, alarms, triggering and release.

4.2.3 The gas is stored in pressurized containers at room temperature.

4.2.4 Automatic detection and triggering devices or manual triggering devices are used to actuate the system. This may be achieved using any approved method or device which can be used to recognize and indicate the presence of heat, flames or smoke in the protected zone.

4.2.5 The control equipment starts alarm devices, if necessary a delay device, and activates the release mechanism of containers and if available selector valves. Automatic triggering and release might be done by mechanical, pneumatic or electrical systems or respective combination of these systems.

4.2.6 The installation may be equipped with automatic devices used to switch off machinery and close fire doors and other equipment, the purpose being to build up and to hold the desired gas concentration.



NOTE: FIGURES IN BOLD IN PARENTHESES DENOTE DESIGN NODES FOR CALCULATIONS

FIG. 1 TYPICAL BALANCED SYSTEM

4.3 Suitability and Application

4.3.1 *Total Flooding Systems*

Gaseous fire extinguishing systems are used primarily to protect hazards that are in enclosures or equipment that, in itself, includes an enclosure to contain the agent for establishment of required concentration and maintenance thereof for the required period. Some typical hazards that may be suitable include, but or not limited to, the following:

a) Enclosures, such as rooms, vaults, enclosed machines, containers, storage tanks and bins.
b) Enclosed electrical hazards, such as transformers, control cubicles, switchboards, circuit breakers, and rotating equipment.
c) Enclosed flammable liquid/gas storage and processing areas.
d) Engines using flammable fuels.
e) Electronic hazards, such as computers, data processing equipment, control room, telecommunication facilities.
f) Sub-floors and other concealed spaces.
g) Other high value assets.

4.3.2 Gaseous fire extinguishing systems may also be used for explosion prevention and suppression where flammable materials may collect in confined area.

4.3.3 The effects of agent decomposition (in case of halocarbon clean agents) on fire protection effectiveness and equipment shall be considered where they are used in hazards with high ambient temperatures (for example, furnaces and ovens).

4.4 Limitations

4.4.1 Gaseous fire extinguishing systems shall not be used on fires involving the following materials unless they are pre-evaluated for the purpose:

a) Certain chemicals or mixture of chemicals, such as cellulose nitrate, gun powder, etc, which are capable of rapid oxidation in the absence of air.
b) Reactive metals, such as lithium, sodium, potassium, magnesium, titanium, zirconium, and plutonium.
c) Metal hydrides or metal amides, some of which may react violently with some gaseous agents.
d) Chemicals capable of undergoing auto-thermal decomposition, such as certain organic peroxides and hydrazine.
e) Mixtures containing oxidizing materials, such as sodium chlorate or sodium nitrate.
f) Environments where significant surface areas exist at temperatures greater than the breakdown temperature of the extinguishing agent and are heated by means other than the fire.

4.4.2 Electrostatic charging of non-grounded conductors may occur during the discharge of gaseous fire extinguishing systems. These conductors may discharge to other objects, causing an electric arc of sufficient charge to initiate explosion in potentially explosive atmospheres. Where this system is used for inerting, pipework shall be adequately bonded and earthed.

4.5 Other Information

4.5.1 All devices in respect of the gaseous fire extinguishing systems shall be designed for the service they will encounter and shall not be readily rendered inoperative or susceptible to accidental operation. Normally, the system components shall be designed to function properly from –21 °C to 55 °C or marked to indicate temperature limitations in accordance with the specifications.

4.5.2 Gaseous fire extinguishing systems may be employed to protect more than one enclosure, if necessary, by means of directional valves. Where there are two or more enclosures simultaneously involved in a fire by reason of their proximity, such enclosures shall be protected by:

a) Individual systems designed to allow simultaneous operation; or
b) A single system sized and arranged to discharge on all potentially involved hazards simultaneously.

4.5.3 Systems employing simultaneous discharge of different agents to protect the same enclosure shall not be permitted.

4.6 Applicability of Clean Agents

4.6.1 The fire extinguishing clean agents addressed in the standard are electrically non-conducting and leave no residue upon evaporation.

4.6.2 Tables 1 and 2 show the details of clean agents that are covered in this standard. While requirements that are common to all these agents are prescribed in this standard, individual requirements for each agent are covered under separate standards.

Table 1 Inert Gas Agents

(*Clause* 4.6.2)

Sl No.	Commercial Name	Clean Agent	Chemical Name
(1)	(2)	(3)	(4)
i)	IG-01	Ar	Argon (100 percent)
ii)	IG-100	N_2	Nitrogen (100 percent)
iii)	IG-541	N_2 Ar CO_2	Nitrogen (52 percent) Argon (40 percent) Carbon dioxide (8 percent)
iv)	IG-55	N_2 Ar	Nitrogen (50 percent) Argon (50 percent)

NOTE — Composition of inert gas agents is given in percent by volume.

Table 2 Halocarbon Agents

(*Clause* 4.6.2)

Sl No. (1)	Commercial Name (2)	Clean Agent Formulae (3)	Chemical Name (4)
i)	HCFC Blend A (*see* Note)	$CHCl_2CF_3$	Dichlorodifluoroethane (HCFC-123, 4.75 percent)
		$CHClF_2$	Chlorodifluoromethane (HCFC-22, 82 percent)
		$CHClFCF_3$	Chlorotetrafluoroethane (HCFC-124, 9.5 percent)
ii)	HFC-227ea	CF_3CHFCF_3	Heptafluoropropane
iii)	FK-5-1-12	$CF_3CF_2C(O)CF(CF_3)_2$	Dodecafluoro-2-methylpentan-3-one
iv)	FIC-1311	CF_3I	Trifluoroiodomethane

NOTE — Composition of HCFC Blend A is given in percent by weight.

4.6.3 Physical properties of the agents covered in this standard are indicated in Tables 3 and 4.

Table 3 Physical Properties of Clean Halocarbon Agents

(*Clause* 4.6.3)

Sl No. (1)	Properties (2)	Units (3)	HCFC Blend A (4)	HFC-227ea (5)	FK-5-1-12 (6)	FIC-1311 (7)
i)	Molecular weight	N/A	92.90	170.03	316.04	195.91
ii)	Boiling point at 760 mm of Hg	°C	−38.3	−16.4	49.2	−22.5
iii)	Freezing point	°C	−107.2	−131	−108	−110
iv)	Critical temperature	°C	124.7	−101.7	168.66	122
v)	Critical pressure	kPa	6 647	2 912	1 865	4 041
vi)	Critical volume	cm^3/mole	162	274	494.5	225
vii)	Critical density	kg/m^3	577	621	639.1	871
viii)	Specific heat, liquid at 25 °C	kJ/kg °C	1.256	1.184	1.103	0.592
ix)	Specific heat, vapour at constant pressure (1 atm)	kJ/kg °C	0.67	0.808	0.891	0.3 618
x)	Heat of vapourization at boiling point	kJ/kg	225.6	132.6	88	112.4
xi)	Thermal conductivity of liquid at 25 °C	W/m °C	0.090	0.069	0.059	0.070
xii)	Viscosity of liquid at 25 °C	Centipoise	0.21	0.184	0.524	0.196
xiii)	Relative dielectric strength at 1 atm at 734 mm Hg (N_2=1)	N/A	1.32 at 25 °C	2 at 25 °C	2.3 at 25 °C	1.41 at 25 °C
xiv)	Solubility of water in agent	ppm	0.12 percent by weight	0.06 percent by weight	< 0.001	1.006 2 percent by weight
xv)	Ozone depletion potential (ODP)	N/A	0.048	0	0	0
xvi)	Global warming potential (GWP) (reported over 100 years of time horizon)	N/A	1.500	3.350	≤ 1	≤ 1

Table 4 Physical Properties of Inert Gas Agents

(*Clause* 4.6.3)

Sl No.	Properties	Units	IG-01	IG-100	IG-541	IG-55
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	Molecular weight	N/A	39.9	28.0	34.0	33.95
ii)	Boiling point at 760 mm of Hg	°C	– 189.85	– 195.8	– 196	– 190.1
iii)	Freezing point	°C	– 189.35	– 201.0	– 78.5	– 199.7
iv)	Critical temperature	°C	– 122.3	– 146.9	N/A	– 134.7
v)	Critical pressure	kPa	4 903	3 399	N/A	4 150
vi)	Specific heat, vapour at constant pressure (1 atm) and 25 °C	kJ/kg °C	0.519	1.04	0.574	0.782
vii)	Heat of vapourization at boiling point	kJ/kg	163	199	220	181
viii)	Relative dielectric strength at 1 atm at 734 mm Hg, 25 °C (N_2 = 1.0)	N/A	1.01	1.0	1.03	1.01
ix)	Solubility of water in agent at 25 °C	percent	0.006	0.001 3	0.015	0.006

4.6.4 As such, both these standards that is for general this standard and individual requirements should be read together before designing a system. Where requirements in both the standards differ, the standard covering individual requirements shall take precedence.

NOTE — Other agents could be covered later as and these those are available and used.

5 REQUIREMENTS REGARDING SUBMISSION OF PLANS

Plans shall contain sufficient details to enable an evaluation of the protected enclosure(s) or local protection(s) *vis-à-vis* the effectiveness of the system. Details shall include the property involved in the hazard(s), location(s), the enclosure limits and isolation of the hazards and the exposure of the hazards.

5. 1 Plans for submission to the authorities shall be drawn up in accordance with the following requirements:

a) Plans shall be clear, contain all required details including scale and point of compass and shall be clearly dated.
b) Name of the enterprise, location and detailed postal address.
c) Location and construction of the protected enclosures, walls and partitions.
d) Cross and longitudinal sectional elevations of the protected enclosures showing the full height, schematic diagram, ceilings, false floors, etc.
e) Type of clean agent proposed to be used.
f) Concentration summary that is design, extinguishing, injected and inerting, etc.
g) Type of the hazards proposed to be protected including descriptions of the occupancies, surroundings, wall/ceiling openings, etc.
h) Location of the gas containers and details of the contents such as volume, pressure, nominal capacity in agent mass at standard conditions of temperatures and pressures.
j) Description of pipes and fittings indicating also their specifications, pressure ratings, etc.
k) Description of nozzles employed indicating their size, orifice area, etc and their locations.
m) Electrical cabling and terminations.
n) Description of detectors employed indicating their locations, mounting, etc.
p) Bill of material and equipment schedule for each component proposed for the system, suppliers/manufacturers names, details of approvals, quantity, etc.
q) Isometric drawings showing the agent distribution system indicating the lengths and diameters of each pipe segment, nodal reference, fittings including unions, reducers, orifices, strainers, nozzles, flow rates in all segments, equivalent orifice areas, etc.
r) Plan view of the enclosures showing the entire agent piping system along with ceiling, floors, false floors, walls, partitions, pipe supports, agent containers, cabling, panels, detectors, etc.
s) Details showing the pipe supports, agent container securement, etc.
t) Location of ducts and similar devices, dampers, air handling systems, venting arrangements and their details with supporting calculations, etc.
u) Schematic display of the operation of the system giving chronological sequence of operations prior to the discharge of the agent into the protected enclosures.
v) Schematic diagrams showing the location and lay-out of all the power and indicating equipment

connections, control panels, annunciator panels, etc.

w) Tables showing the calculations for enclosure volumes, agent quantity, methods used to determine number and location of audible and visual indicating equipment, number and location of detectors, etc.

y) Other features like interconnection with other type of fire protection systems, etc with the proposed system.

z) To indicate fire rating of walls between rooms or enclosure for the areas protected.

5.2 The details of the system shall include information and calculations on the amount of agent, container storage pressure internal volume of the containers, the location, type and flow rate of each nozzle including equivalent orifice area, the location, size and equivalent lengths of pipe, fittings, siphon tube, valve, discharge head and flexible connector hose, and the location and size of the storage facility. Pipe size reductions and orientation of 'tees' shall be clearly indicated. Details shall be available on location and function of the detection devices, operating devices, auxiliary equipment and electrical circuitry. All the apparatus, equipment used in the system shall be easily identifiable.

5.3 An 'as built' drawing shall be submitted upon completion of the installation for approval. Instruction and maintenance manuals that include a full sequence of operations and a full set of drawings and calculations shall be available on site.

5.4 Flow Calculations

System flow calculations along with the working drawings shall be submitted to the authorities in advance for approval. The hydraulic calculations shall be performed using calculation method approved by the authorities.

6 SAFETY REQUIREMENTS

6.1 Safety Precautions (Personnel)

6.1.1 Halocarbon clean agents are potentially cardio-toxic while inert gas clean agents can present physiological effects associated with a hypoxic (that is, low oxygen) atmosphere. The experimentally determined no observed adverse effects level (NOAEL) and lowest observed adverse effects level (LOAEL) values, which are indicated in Table 5 for the halocarbon agents. The corresponding NOAEL and LOAEL values for the inert gas agents have been set at 12 percent oxygen (43 percent inert gas concentration) and 10 percent oxygen (52 percent inert gas concentration) respectively. Inert gas mixture concentrations (for example, IG 541) can only be determined indirectly by measuring the oxygen concentration within an enclosure.

6.1.2 The clean agent system design extinguishing concentration ideally should be less than the NOAEL for the specific clean agent for occupiable areas. Also,

a) discharge of some of the gas agents in fire extinguishing concentrations creates serious hazards for personnel in both the protected area and the areas to which the gas may migrate and also to properties in the vicinity of agent discharge. These hazards may include reduced visibility and suffocation, during and after the discharge period. The relevant information on the above is available in Annex B.

b) the toxicity information on the gaseous fire agents is given in Table 5. More details are specified in other parts (that is for the individual clean agents) of this standard. Where hazardous concentrations of agent may exist, lock-off valves shall be fitted to the system.

c) in areas, where there is a likelihood of significant difference between gross and net volumes of the enclosure, utmost care shall be exercised in proper system design to ensure that maximum concentrations are not exceeded.

6.1.3 The decomposition products generated by the clean agent breaking down in the presence of very high degrees of heat can be hazardous. All of the present halocarbon agents contain fluorine. In the presence of available hydrogen (from water vapour or the combustion process itself), the main decomposition product is hydrogen fluoride (HF).

6.1.4 *Safety Precautions (For Protected Areas)*

a) *Normally Occupied Areas* — The minimum safety precautions taken shall be in accordance with Table 6 and provisions therein.

b) *Normally Unoccupied Areas* — The maximum concentration shall not exceed the LOEAL for the agent used unless a lock-off valve is fitted.

NOTE — Any change to the enclosure volume, or addition or removal of contents that was not covered in the original design will affect the concentration of agent. In such instances the system shall be re-calculated to ensure that the required design concentration is achieved and that the NOEAL or the LOEAL are not exceeded.

6.1.5 *Protection of Occupants*

In any use of the gaseous system, where there is a possibility that people may enter or have difficulty seeking egress from the protected enclosure, suitable safeguards shall be provided. Such safety aspects as personal training, warning signs, pre-discharge alarms and safety interlocks shall be provided. Means of proper ventilation after fire should be readily available.

Table 5 Toxicity Information on Clean Agent Suppression Systems

[*Clauses* 6.1.1 *and* 6.1.2 (b)]

Sl No.	Clean Agent	Chemical Formula	NOAEL	LOAEL	LC_{50} or ALC
			percent by volume		
(1)	(2)	(3)	(4)	(5)	(6)
i)	HCFC blend A	$CHCl_2CF_3$ (4.75 percent) $CHClF_2$ (82 percent) $CHClCF_3$ (9.5 prcent) Detoxifier (3.75 percent)	10	> 10	64
ii)	HFC-227ea	CF_3CHFCF_3	9	10.5	> 80
iii)	FK-5-1-12	$CF_3CF_2C(O)CF(CF_3)_2$	10	> 10	64
iv)	FIC-1311	CF_3I	0.2	0.4	> 12.8
v)	IG-541	Nitrogen (52 percent) Argon (40 percent) Carbon dioxide (8 percent)	43	52	Not applicable
vi)	IG-100	Nitrogen	43	52	Not applicable
vii)	IG-55	Nitrogen (50 percent) Argon (50 percent)	43	52	Not applicable
viii)	IG-01	Argon (100 percent)	43	52	Not applicable

NOTES

1 LC_{50} is the concentration lethal to 50 percent of a rat population during a 4 h exposure.

2 The ALC is the approximate lethal concentration.

Table 6 Minimum Safety Precautions

[*Clause* 6.1.4 (a)]

Sl No.	Agent Levels	Requirements			
		Inhibit Switch and Time Delay	Egress in 30 s	Safety Interlock	Lock-off Valve
(1)	(2)	(3)	(4)	(5)	(6)
i)	HCFC blend A	Required	Not required	Not required	Not required
ii)	HFC-227ea	Required	Required	Required	Not required
iii)	FK-5-1-12	Required	Not required	Required	Required

NOTES

1 The purpose of the table is to avoid unnecessary exposure of occupants to the agent discharged. Factors such as the time for egress and the risk to the occupants by the fire must be considered when determining the system discharge time delay.

2 Concentration levels above LOAEL are not permitted in occupied areas and question of egress does not arise.

6.2 Safety Precautions (Total Flooding Systems)

6.2.1 In areas protected by total flooding systems, that are capable of being occupied, the provision of the following safety aspects shall apply:

a) *Mandatory Requirements*

   1) A time delay shall be provided for evacuation prior to agent discharge. The agent discharge delay time shall be based on an engineering assessment of egress time for occupants in the area protected.
   2) Safety interlocks and lock-off valves shall be provided wherever required as per Table 2 under **6.1.4**(a).
   3) Exit routes which shall be kept clear at all times; and the provision of emergency lighting and adequate direction signs to minimize travel distances.
   4) Outward swinging self-closing doors which can be opened from inside including when locked from the outside.

    5) Continuous visual and audible alarms at entrances and designated exits until the protected area has been made safe.
    6) Warning and instruction signs shall be arranged as per clause.
    7) Pre-discharge alarms within such areas that are distinctive from all other alarm signals and that will operate immediately upon detection of fire.
    8) Means of prompt ventilation of such areas after any discharge of agent. Forced draft ventilation will often be necessary. Care shall be taken to completely dissipate hazardous atmospheres and not just move them to other locations, as agents are generally heavier than air.
    9) Instructions and drills of all personnel within or in the vicinity of protected areas, including maintenance and construction personnel who may be brought into the area, to ensure their correct actions when the system operates.

b) *Recommendatory Requirements*
    1) Adding an odour to the agent so that the hazardous atmospheres are recognizable.
    2) Availability of self-contained breathing apparatus and personnel trained for its use.
    3) Means to detect a hazardous atmosphere in or around the protected area.

6.2.2 *Electrostatic Discharge*

To avoid a situation as stated in **4.4.2**, the components of the inerting system, such as pipe work, etc shall be bonded and earthed as per SP 30.

6.3 Electrical Hazards

6.3.1 All system components shall be located to maintain no less than minimum clearances from energized electrical parts. Installation shall conform to various requirements prescribed in SP 30.

6.3.2 Where the design basic insulation level (BIL) is not available and where nominal voltage is used for the design criteria, the highest minimum clearance listed in SP 30 shall be used.

6.3.3 The selected clearance to ground shall satisfy the greater of the switching surge rather than being based on nominal voltage.

6.3.4 The clearance between uninsulated, energized parts of the electrical system equipment and any portion of the clean agent system shall not be less than the minimum clearance provided for electrical system insulation on any individual component.

6.3.5 Where BIL is not available and where nominal voltage is used for the design criteria, the highest minimum clearance listed in SP 30 shall be used.

6.4 Miscellaneous Hazards

Certain other types of hazards associated with the usage of gaseous systems are as under:

a) *Noise* — Discharge of a gaseous system can cause a noise loud enough to be startling, but not enough to cause traumatic injury.
b) *Turbulence* — The turbulence caused by the high velocity discharge from nozzles may be sufficient to dislodge substantial objects directly in its path, such as ceiling tiles and light fittings. Therefore, tiles and light fittings should be properly anchored. System discharge may also cause enough general turbulence in the enclosure to move unsecured paper and light objects.
c) *Electrical clearance* — Where exposed electrical conductors are present, all system components shall be located no less than the minimum required clearances from the energized parts. The clearances stipulated in SP 30 shall be maintained for safe operating conditions. Where the design basic insulation level is not available and where nominal voltage is used for the design criteria the highest minimum clearance listed for the purpose shall be used.
d) *Other Hazards* — If any, appropriate to the selected gaseous agent as specified in the other parts of this standard shall be given due attention.

7 REQUIREMENTS FOR THE PROTECTED ENCLOSURES

7.1 Unclosable Openings

Some of the unclosable openings are listed below:

a) The protected enclosure shall have sufficient structural strength and integrity to contain the agent discharge.
b) The area of the unclosable openings such as ventilator openings within the enclosure shall be kept to as least as possible to avoid ingress of the agent through the leakages to the adjoining areas. Where confinement of the agent within the enclosure is not practicable, protection shall be extended to include the adjacent connected hazards or work areas.
c) Particular attention should be given to openings around cable, duct and pipelines (similar utility services) penetrating through the wall(s) and floor(s).
d) In case of unavoidable openings, such openings should be restricted to as minimum as possible. Quantity of the agent, in such cases, shall need to be suitably increased in consultation with the authorities concerned for maintaining the desired concentration within the enclosure.

e) In case of (c), the openings should be effectively sealed or preferably fire stopped using passive elements rather than increasing the quantity of the agent.

f) Injecting more quantity of agent, in most of the cases, will only increase the rate of loss of agent through such openings. Hence, openings in the wall(s) and floor(s) shall be kept only to optimum requirements with increase in quantity of agent as discussed in (d).

7.2 Air Handling System and Similar Services

The requirements shall be as given below:

a) Humidification and air handling systems catering to the protected areas shall be capable of automatic shutdown prior to the agent discharge. Also, dampers shall be available inside the systems to stop flow of agent through ducts and similar means and these shall close automatically prior to agent discharge.

b) Where it is necessary for air handling systems to be kept operating to provide cooling arrangement for essential equipment, quantity of the agent shall need to be suitably increased to include the volumes of both air and the ventilation system in addition to the volume of protected enclosure in consultation with the authorities concerned for maintaining the desired concentration within the enclosure.

c) The operations within the enclosure that are likely to disperse the discharge of the agent such as pumps, spray guns, heaters, etc shall not be left running during the discharge of the agent and suitable provisions shall be available to shut them down prior to agent discharge.

d) In case of extinguishment of deep-seated fires such as those involving solids, unclosable openings shall be provided only in the ceiling level and such openings near the walls and partitions shall be avoided.

8 COMPONENTS OF GASEOUS FLOODING SYSTEMS

8.1 Agent Supply and Container Arrangements

8.1.1 *Agent Supply*

The following shall be applicable:

a) *Quality Requirements* — The clean agent shall comply with quality and purity standards appropriate to the agent selected for extinguishment. Each batch of agent manufactured shall be tested and certified to applicable specifications. Agent blends shall remain homogeneous in storage and used within the listed temperature range and environmental conditions at the place of installation.

b) *Quantity Requirements (Main)* — The amount of agent in the system shall be at least sufficient for the largest single hazard or group of hazards to be protected simultaneously.

c) *Quantity Requirements (Reserve)* — Same quantity as that of main quantity requirements shall be available as reserve. However, if the replenishing of agent supply takes more than 7 days at the site of installation, authority concerned may insist on more quantity to be kept available as reserve.

d) *Uninterrupted Protection* — Where uninterrupted protection is required, both the main and reserve supply shall be permanently connected to the distribution piping and arranged for easy change-over.

8.1.2 *Agent Storage*

The following shall apply:

a) Agent shall be stored in containers designed to hold that specific agent at ambient temperatures.

b) Agent containers shall be charged to a fill density or super-pressurization level within the range specified by the manufacturers.

c) Agent storage temperatures shall not exceed 55 °C or be less than –21 °C. External heating or cooling shall be employed to keep the temperature of the agent storage container within the above limits if situation warrants so.

d) The agent containers used in the flooding systems shall be designed to meet the requirements of the *Department of Explosives, Nagpur*.

e) Each agent container shall have a permanent nameplate or other permanent marking that indicate the details as per Table 7.

f) A reliable means shall be provided to determine the pressure in refillable super-pressurized containers.

g) The agent containers connected to a common manifold shall conform as per the provisions in Table 8 and automatic by means, such as a check valve, shall be provided to prevent agent loss and to ensure personnel safety if the system is operated when any containers are removed for maintenance.

Table 7 Marking on Storage Container

[*Clause* 8.1.2 (e)]

Sl No. (1)	Clean Agent (2)	Marking Required (3)
i)	Halocarbon clean agents	a) Name of the agent b) Tare and gross weights c) Super-pressurization level of the container
ii)	Inert gas clean agent	a) Name of the agent b) Pressurization level of the container c) Nominal agent volume

Table 8 Arrangement of Containers with Common Manifold

[*Clause* 8.1.2 (g)]

Sl No. (1)	Clean Agent (2)	Marking Required (3)
i)	Halocarbon clean agents	Agents in a multiple container system. All containers supplying the same manifold outlet for distribution of the same agent shall be interchangeable, of same nominal size and capacity, filled with same nominal mass of agent and pressurized to the same nominal working pressure.
ii)	Inert gas clean agent	Agents shall be permitted to utilize multiple storage container sizes connected to the common manifold provided the containers are all pressurized to the same nominal working pressure.

8.1.3 *Storage Container Arrangement*

The arrangement of storage containers and accessories shall be as follows:

a) Containers and accessories shall be located and arranged so that inspection, testing, recharging and other maintenance is facilitated, and interruption to protection is kept to a minimum.

b) Containers should be located outside and as near as practical to the enclosure protected. Containers protecting a single risk can be located within the enclosure they serve, only if sited so as to minimize the risk of exposure to fire and explosion.

c) Containers shall be located so as not to be subject to severe weather conditions or to mechanical, chemical or other damage. Where excessive climatic or mechanical exposures are expected, suitable guards or enclosures shall be provided.

d) Containers shall be adequately mounted to allow free passage of air around the base and suitably supported to provide for convenient individual servicing or content weighing. There shall be enough space for a full on-site inspection of the base of the container.

e) In manifold systems, non-return valves or other automatic means shall be provided to prevent a loss of agent and to ensure personnel safety if the system is operated when any containers are removed for maintenance.

f) Containers brackets or devices integral with the container for attachment to structures shall be designed to cater for the maximum expected mass, vibration effects and shock loading, appropriate to the installation.

g) Reserve containers, where provided, shall be permanently sited or arranged for easy change-over.

h) If storage containers are located in areas where their leakage could lead to a hazardous concentration, consideration shall be given to the installation of gas detectors or other means to provide warning of the onset of hazardous conditions.

8.2 Agent Distribution Arrangements

8.2.1 *General*

The general requirements shall be as below:

a) Pipe network, fittings shall be of non-combustible construction, having physical and chemical properties such that their integrity under stress can be predicted with reliability.

b) In severely corrosive atmospheres, special corrosion resistant materials shall be required for pipes, fittings or support brackets and steelwork.

c) Before final assembly, pipes and fittings shall be inspected visually to ensure they are free of burrs, spelter and rust and that no foreign matter is inside and the full bore is clear. After assembly, the system shall be thoroughly blown through with dry air or compressed gas. The pipe work shall be free of particulate matter and oil residue before the installation of nozzles and discharge devices.

d) A dirt trap consisting of a 'tee' with a capped nipple at least 50 mm long should be installed at the end of each pipe run. Drain traps should also be necessary if there is a possibility of a build-up of water.

e) In systems where valve arrangements introduce sections of closed piping, such sections shall be equipped with the following:
    1) Indication of agent trapped in piping.
    2) Means for safe manual venting.
    3) Automatic relief of excess pressure, where required.

f) Pressure relief devices, which can include the directional valve, shall be fitted so that the discharge, in the event of operation, will not endanger the personnel.

g) In systems using pressure operated container valves, automatic means shall be provided to vent any container leakage that could build up pressure in the pilot system and cause unwanted opening of the container valve. The means provided for pressure venting shall not prevent operation of the container valve.

8.2.2 *Piping Network*

The quality (and any conformity) requirement of the piping network shall be as follows:

a) Cast iron or non-metallic pipes shall not be used anywhere.

b) Where used, flexible pipes, tubing, or hoses including connections shall be of approved materials with adequate temperature and pressure ratings.

c) The thickness of the pipes shall be in accordance with the provisions laid down in IS 6631. The internal pressure used for this calculation shall not be less than the greater of either of the following values:

   1) Normal charging pressure in the agent container at 21 °C.

   2) 80 percent of the maximum pressure in the agent container at the maximum storage temperature of not less than 55 °C using the maximum allowable fill density specified by the manufacturer, if applicable.

d) In no case shall the value used, for the minimum piping design pressure, be less than that specified in Tables 9 and 10 shown below for the conditions indicated.

e) For inert gas clean agents that employ the use of a pressure-reducing device, Table 10 shall be used for piping upstream of the pressure reducer, and **8.2.2** (f) shall be used to determine minimum pipe design pressure for piping downstream of the pressure reducer. The pressure-reducing device shall be readily identifiable.

f) For systems that employ the use of a pressure reducing device, the minimum design pressure for piping downstream of the pressure-reducing device shall be determined from the maximum anticipated pressure in the downstream piping as predicted by system flow calculations.

g) For halocarbon agents, Table 9 shall be used; and for inert gas agents Table 10 shall be used.

h) Where different fill densities, pressurization levels or higher storage temperatures other than the values shown in the Table 9 are used with prior acceptance of the authorities, the minimum design pressure for the piping shall be adjusted to the maximum pressure in the agent container at maximum temperature, using the basic design criteria specified (c) (1) and (c) (2).

j) Pipe joints shall be either threaded, welded or

Table 9 Minimum Design Working Pressure for Halocarbon Clean Agent System Piping

[*Clause* 8.2.2 (d) *and* 8.2.2 (g)]

Sl No.	Clean Agent	Agent Container Maximum Fill Density kg/m^3	Agent Container Charging Pressure at 21 °C kPa	Agent Container Pressure at 55 °C kPa	Minimum Piping Design Pressure at 21 °C kPa
(1)	(2)	(3)	(4)	(5)	(6)
i)	HFC-227ea	1 265	300	900	2 900
		1 201	1 000	1 700	1 400
		1 153	2 500	3 600	2 900
		1 153	4 200	7 100	5 700
ii)	HCFC blend A	900	4 100	5 900	4 700
		900	2 500	3 700	3 000
iii)	FK-5-1-12	1 442	1 000	1 200	1 000
		1 442	1 300	1 600	1 300
		1 442	2 500	2 800	2 500
		1 201	3 400	4 000	3 400
		1 442	4 200	4 800	4 200

NOTE — Nitrogen delivered to agent cylinder through a flow restrictor upon system actuation. Nitrogen supply cylinder pressure is 124 bar at 21 °C.

Table 10 Minimum Design Working Pressure for Inert Gas Clean Agent System Piping

[*Clause* 8.2.2 (d), 8.2.2 (e) *and* 8.2.2 (g)]

Sl No. (1)	**Clean Agent** (2)	**Agent Container Charging Pressure at 21 °C** kPa (3)	**Agent Container Pressure at 55 °C** kPa (4)	**Minimum Piping Design Pressure at 21 °C** kPa (5)
i)	IG-01	16 341	18 271	16 341
		20 436	22 781	20 436
		31 097	37 244	31 097
ii)	IG 541	14 997	17 755	14 997
		19 996	23 671	19 996
		31 050	36 950	31 050
iii)	IG-55	15 000	17 600	15 000
		20 000	23 700	20 000
		30 000	36 100	30 000
iv)	IG-100	16 575	19 299	16 575
		22 312	26 015	22 312
		28 000	32 778	28 000

flanged type only and other types of jointing shall not be allowed.

8.2.3 *Pipe Fittings*

a) The sizes and dimensions of pipe fittings shall be in accordance with IS 1239 (Part 2). Fittings shall be capable to withstand minimum rated working pressure equal to or greater than the minimum working pressure specified in **8.2.2**(c) for the clean agent being used. For systems that use a pressure reducing device in the distribution piping, the fittings downstream the device shall have a minimum rated working pressure equal to or greater than the maximum anticipated pressure in the downstream piping.

b) All threads used in joints and fittings shall comply with relevant Indian Standards. Cast iron fittings shall not be used.

c) Welding of joints shall comply with relevant Indian Standards.

d) Where copper, stainless steel, or other suitable tubing is jointed with compression type fittings, manufacturer’s pressure and temperature ratings of the fittings shall not be exceeded.

8.2.4 *Valves*

a) All valves shall comply with relevant Indian Standards.

b) Gaskets, O-rings, sealants, and other valve components shall be fabricated with materials that are compatible with the agent used and also suitable for the anticipated pressures and temperatures.

c) Valves shall be protected against mechanical, chemical and other types of damage.

d) Special corrosion resistant materials or coating shall be used in severely corrosive atmospheres.

e) Where directional valves are used for multi-hazard protection:

   1) valves shall be of approved type for use with the installed suppression system; and

   2) the control equipment shall be specifically listed for the number, type, and operation of those valves.

8.2.5 *Pipe Installation and Supports*

a) In the installation of pipe work, care shall be taken to avoid possible restrictions due to foreign matter, faulty fabrication or improper installation. Pipe ends shall be reamed after cutting, where required.

b) Where there is a possibility of explosion, the piping shall be attached to supports that are least likely to be displaced.

c) The maximum distance between supports shall take into account the total mass of pipe and the agent used. Distance between supports is indicated in Table 11.

Table 11 Maximum Pipe Work Distances

[*Clause* 8.2.5 (c)]

Sl No. (1)	Nominal Diameter of Pipe mm (2)	Maximum Pipe Work Distance m (3)
i)	6	0.5
ii)	10	1
iii)	15	1.5
iv)	20	1.8
v)	25	2.1
vi)	32	2.4
vii)	40	2.7
viii)	50	3.4
ix)	65	3.5
x)	80	3.7
xi)	100	4.3
xii)	125	4.8
xiii)	150	5.2
xiv)	200	5.8

8.2.6 *Discharge Nozzles*

a) Nozzles, including nozzles directly attached to containers, shall be of approved type and located with the geometry of the enclosure under consideration,

b) The type, number and placement of nozzles shall be such that,

   1) the design concentration shall be achieved in all parts of the enclosure;

   2) the discharge shall not unduly splash flammable liquids or create dust clouds that might extend the fire, create an explosion or otherwise adversely affect the occupants;

   3) the velocity of discharge shall not adversely affect the enclosure or its contents;

   4) they are free of obstructions that could interfere with the proper distribution of the discharged agent in accordance with the manufacturer's installation and maintenance manual;

   5) the discharge nozzles shall be provided with frangible discs or blow-out caps where clogging by foreign materials is possible. These devices shall provide an unobstructed opening upon system operation and shall be arranged so they will not injure personnel;

   6) nozzle shall be suitable for the intended use and shall be listed or approved for discharge characteristics. The discharge nozzle consists of the orifice and any associated horn, shield or baffle;

   7) nozzles shall be of adequate strength for use with the expected working pressures, be able to resist nominal mechanical abuse, and be constructed to withstand expected temperatures without deformation;

   8) nozzle discharge orifice inserts shall be of corrosion-resistant material; and

   9) nozzles used in local application systems shall be so connected and supported that they will not readily be moved out of alignment.

c) In order to minimize the possibility of lifting or displacement of light weight ceiling tiles, precautions shall be taken to securely anchor the tiles for a minimum distance of 1.5 m from each discharge nozzle.

8.2.7 *Directional Valves*

a) Directional valves shall be located outside the danger zone resulting from a fire in the flooding zone. No flammables shall be stored in the immediate vicinity of a directional valve.

b) Directional valves shall be arranged so that they will not open when subjected to operating environmental vibration that arises when the valve at the supply container or other directional valves opening.

c) Automatic actuation of a directional valve shall be powered by static weight and/or pneumatic and/or electrical means. The unit shall be designed in such a way that checking for proper functioning on site can be achieved without discharging gas.

d) If it is possible to release the extinguishant, even though the mechanism used to automatically open the directional valve has failed, the emergency release mechanism shall not circumvent national standards for personnel safety the equipment required to prevent damage from excess pressure being exerted by the gas being discharged into the flooding zone.

e) Directional valves shall open automatically and simultaneously with the opening of a container valve.

f) Pressure relief devices from safety valves shall discharge gas into the atmosphere away from windows, especially in basements, ventilation openings, etc. In no case, shall this constitute a hazard to personnel. Safety valves have to be assembled vertically.

9 DETECTION, ACTUATION, ALARM AND CONTROL SYSTEMS

9.1 General

9.1.1 Detection, actuation, alarm and control systems shall be installed, tested and maintained in accordance with IS 2189.

9.1.2 Automatic detection and automatic actuation shall be used.

9.2 Automatic Detection

9.2.1 Automatic detection shall be by any approved method or device capable of detecting and indicating heat, flame, smoke, combustible vapours or an abnormal condition in the hazard, such as process trouble, that is likely to produce fire.

9.2.2 Adequate and reliable primary and 24 h minimum standby sources of energy shall be used to provide for operation of the detection, signaling, control and actuation requirements of the system.

9.2.3 When a new agent system is being installed in a space that has an existing detection system, an analysis shall be made of the detection devices to assure that the detection system is in good operating condition and will respond promptly to a fire situation. This analysis shall be done to assist in limiting the decomposition products from a suppression event.

9.3 Operating Devices

9.3.1 Operating devices shall include agent releasing devices or valves, discharge controls and shutdown equipment necessary for successful performance of the system.

9.3.2 Operation shall be by listed mechanical, electrical or pneumatic means. An adequate and reliable source of energy shall be used.

9.3.3 All devices shall be designed for the service they will encounter and shall not readily be rendered inoperative or susceptible to accidental operation. Devices normally shall be designed to function properly from –21 °C to 55 °C or marked to indicate temperature limitations.

9.3.4 All devices shall be located, installed or suitably protected so that they are not subject to mechanical, chemical or other damage that would render them inoperative.

9.3.5 A mean of manual release of the system shall be provided. Manual release shall be accomplished by a mechanical manual release or by an electrical manual release when the control equipment monitors the battery voltage level of the standby battery supply and will provide a low battery signal. The release shall cause simultaneous operation of automatically operated valves controlling agent release and distribution.

9.3.6 A discharge pressure switch shall be required where mechanical system actuation is possible.

9.3.7 The discharge pressure switch shall provide an alarm-initiating signal to the releasing panel.

9.3.8 A means of manual release shall not be required for automatic systems when the hazard being protected is unoccupiable and the hazard is in a remote location where personnel are not normally present.

9.3.9 The normal manual control(s) for actuation shall be located for easy accessibility at all times, including at the time of a fire. The manual control shall preferably be situated outside the protective area or adjacent to the main exit. The manual control(s) shall be of distinct appearance and clearly recognizable for the purpose intended. Operation of any control shall cause the complete system to operate in its normal fashion.

9.3.10 Manual controls shall not require a pull of more than 40 kg (178 N) nor a movement of more than 355 mm to secure operation. At least one manual control for activation shall be located not more than 1.2 m above the floor.

9.3.11 Where gas pressure from the system or pilot containers is used as a means for releasing the remaining containers, the supply and discharge rate shall be designed for releasing all of the remaining containers.

9.3.12 All devices for shutting down supplementary equipment shall be considered integral parts of the system and shall function with the system operation.

9.3.13 All manual operating devices shall be identified as to the hazard they protect.

9.3.14 The manual operation device shall incorporate a double action or other safety device to prevent accidental operation. The device shall be provided with a means for preventing operation during maintenance of the system.

9.4 Control Equipment

9.4.1 *Electric Control Equipment*

a) Control equipment shall supervise the actuating devices and associated wiring and, as required, cause actuation. The control equipment shall be specifically listed for the number and type of actuating devices utilized and their compatibility shall have been approved.
b) Removal of an electric actuator from the agent storage container discharge valve that it controls shall result in an audible and visual indication of system impairment at the system releasing control panel.
c) Removal of an electric actuator from the selector valve it controls shall result in an audible and visual indication of system impairment at the system releasing control panel.
d) The control equipment shall supervise the actuating devices and associated wiring and, as required, cause actuation.

- e) The control equipment shall be specifically approved for the number and type of actuating devices utilized, and their compatibility shall have been listed.
- f) Removal of the primary agent container actuating device from the discharge valve and/or selector valve shall cause a trouble or supervisory signal at the releasing control unit.

9.4.2 *Pneumatic Control Equipment*

- a) Where pneumatic control equipment is used, the lines shall be protected against crimping and mechanical damage.
- b) Where installations could be exposed to conditions that could lead to loss of integrity of the pneumatic lines, special precautions shall be taken to ensure that no loss of integrity will occur.
- c) The control equipment shall be specifically approved for the number and type of actuating devices utilized and their compatibility shall have been approved.

9.5 Operating Alarms and Indicators

9.5.1 Alarms or indicators or both shall be used to indicate the operation of the system, hazards to personnel, or failure of any supervised device. The type (audible, visual or olfactory), number, and location of the devices shall be such that their purpose is satisfactorily accomplished. The extent and type of alarms or indicator equipment or both shall be approved.

9.5.2 Audible and visual pre-discharge alarms shall be provided within the protected area to give positive warning of impending discharge. The operation of the warning devices shall be continued after agent discharge until positive action has been taken to acknowledge the alarm and proceed with appropriate action.

9.5.3 Abort switches generally are not recommended, however, where provided, the following requirements shall receive attention:

- a) Abort switches shall be located within the protected area and shall be located near the means of egress from the area.
- b) An abort switch shall not be operated unless the cause for the condition is known and corrective action can be taken.
- c) The abort switch shall be of a type that requires constant manual pressure to cause abort.
- d) The abort switch shall not be of a type that would allow the system to be left in an aborted mode without someone present.
- e) In all cases the normal and manual emergency control shall override the abort function. Operation of the abort function shall result in both audible and distinct visual indication of system impairment. The abort switch shall be clearly recognizable for the purpose intended.

9.5.4 Alarms indicating failure of supervised devices or equipment shall give prompt and positive indication of any failure and shall be distinctive from alarms indicating operation or hazardous conditions.

9.5.5 Warning and instruction signs at entrances to and inside protected areas shall be provided.

9.5.6 Indication lamps shall be provided to indicate the status of the abort switch, that is, green colour for ‘Auto’, yellow colour for the ‘Manual’ and red colour for ‘Discharge’ modes.

9.6 Time Delays

9.6.1 For clean agent extinguishing systems, a pre-discharge alarm and time delay, sufficient to allow personnel evacuation prior to discharge, shall be provided. For hazard areas subject to fast growth fires, where the provision of a time delay would seriously increase the threat to life and property, a time delay shall be permitted to be eliminated.

9.6.2 Time delays shall be used only for personnel evacuation or to prepare the hazard area for discharge.

9.6.3 Time delays shall not be used as a means of confirming operation of a detection device before automatic actuation occurs.

9.7 Unwanted System Function

- a) To avoid unwanted discharge of an electrically actuated clean agent system, a supervised disconnect switch shall be provided.
- b) The disconnect switch shall interrupt the releasing circuit to the suppression system.
- c) The disconnect switch shall cause a supervisory signal at the releasing control unit.
- d) The disconnect switch shall be located inside a lockable fire alarm control panel, inside a lockable enclosure, or require a key for activation of the switch.
- e) When the disconnect switch requires a key for activation, the access key shall not be removable while disconnected, so the suppression system can be quickly returned to the operational condition in the event of a fire.
- f) Suppression system disconnect achieved *via* software programming shall not be acceptable for use *in lieu of* a physical disconnect switch.
- g) The disconnect switch shall be of approved type.

10 COMMISSIONING AND ACCEPTANCE

10.1 The minimum requirements for the commissioning and acceptance of the gaseous extinguishing system shall be as follows.

10.2 Tests

10.2.1 *General*

The completed system shall be reviewed and tested by a competent person to meet the approval of the authority. Only equipment and devices designed to relevance specification standards shall be used in the systems. To determine that the system has been properly installed and will function as specified, the tests specified in **10.2.2** to **10.2.9** shall be performed.

10.2.2 *Enclosure Check*

a) It shall be cross-checked that the protected enclosure is in general conformity with the approved drawings.
b) The enclosure shall be inspected to determine if penetrations have occurred that could lead to agent leakage, if other changes have occurred that could change volume of hazard, or both. Where the inspection indicates conditions that could result in the inability of the enclosure to maintain the clean agent concentration, the conditions shall be corrected.

10.2.3 *Review of Mechanical Components*

10.2.3.1 The piping distribution system shall be inspected to determine that it is in compliance with the design and installation documents.

10.2.3.2 Nozzles and pipe sizes, and if appropriate, pressure-reducing devices, shall be in accordance with system drawings. The means for pipe size reduction and attitudes of tees shall be checked for conformity to the design.

10.2.3.3 Piping joints, discharge nozzles and piping supports shall be securely fastened to prevent unacceptable vertical or lateral movement during discharge. Discharge nozzles shall be installed in such a manner that piping cannot become detached during discharge.

10.2.3.4 During assembly, the piping distribution system shall be inspected internally to detect the possibility of any oil or particulate matter which could spoil the hazard area or affect the agent distribution due to a reduction in the effective nozzle orifice area.

10.2.3.5 The discharge nozzles shall be oriented in such a manner that optimum agent dispersal can be affected.

10.2.3.6 If nozzle deflectors are installed, they shall be positioned to obtain the maximum benefit.

10.2.3.7 The discharge nozzles, piping and mounting brackets shall be installed in such a manner that they will not potentially cause injury to personnel. Agent shall not directly impinge on areas where personnel may be found in the normal work area, or on any loose objects or shelves, cabinet tops, or similar surfaces where loose objects could be present and become missiles.

10.2.3.8 All agent storage containers shall be properly located in accordance with 'approved for construction' set of system drawings.

10.2.3.9 All containers and mounting brackets shall be securely fastened in accordance with the manufacturer's requirements.

10.2.3.10 An adequate quantity of agent to produce the desired specified concentration shall be provided. The actual enclosure volumes shall be checked against those indicated on the system drawings to ensure the proper quantity of agent. Fan rundown and damper closure time shall be taken into consideration.

10.2.3.11 Unless the total piping contains not more than one change in direction fitting between the storage container and the discharge nozzle, and unless all piping has been physically checked for tightness, the following tests shall be carried out:

a) All open-ended piping shall be pneumatically tested in a closed circuit for a period of 10 min at 300 kPa. At the end of 10 min, the pressure drop shall not exceed 20 percent of the test pressure.
b) All closed-section pipe work shall be hydrostatically tested to a minimum of 1.5 times the maximum working pressure for 2 min during which there shall be no leakage. On completion of the test, the pipe work shall be purged to remove moisture.

10.2.3.12 It is recommended that hydrostatic testing be carried out at the manufacturer's works where practicable.

> WARNING — Pneumatic pressure testing creates a potential risk of injury to personnel in the area, as a result of airborne projectiles if rupture of the piping system occurs. Prior to conducting the pneumatic pressure test, the protected area shall be evacuated and appropriate safeguards shall be provided for test personnel.

10.2.3.13 A test using nitrogen, or a suitable alternative, shall be performed on the piping network to verify that flow is continuous and that the piping and nozzles are unobstructed.

10.2.3.14 Where required, suitable venting facilities shall be provided for the release of excessive pressure build-up during discharge of the agent. Individual standards for gaseous agents provide details for the design of venting facilities.

10.2.4 *Review of Electrical Components*

10.2.4.1 All wiring systems shall be properly installed in compliance with IS 732 and the system drawings. The a.c. and d.c. wiring shall not be combined in a common conduit unless properly shielded and grounded.

10.2.4.2 All field circuitry shall be tested for ground fault and short circuit condition. When testing field circuitry, all electronic components (such as smoke and flame detectors or special electronic equipment for other detectors, or their mounting bases) shall be removed and jumpers properly installed to prevent the possibility of damage within these devices. Replace components after testing the circuits.

10.2.4.3 Adequate and reliable primary standby sources of energy which comply with **9.2.2** shall be used to provide for operation of the detection, signaling, control and actuation requirements of the system.

10.2.4.4 All auxiliary functions (such as alarm sounding or displaying devices, remote annunciators, air handling shutdown, power shutdown, etc) shall be checked for proper operation in accordance with system requirements and design specifications.

10.2.4.5 Alarm devices shall be installed so that they are audible and visible under normal operating and environmental conditions.

10.2.4.6 Where possible, all air handling and power cut-off controls should be of the type that once interrupted require manual restart to restore power.

10.2.4.7 Check that for systems using alarm silencing, this function does not affect other auxiliary functions, such as air handling or power cut-off where they are required in the design specification.

10.2.4.8 Check the detection devices to ensure that the types and locations are as specified in the system drawings and are in accordance with the manufacturer's requirements.

10.2.4.9 Check that manual release devices are properly installed, and are readily accessible, accurately identified and properly protected to prevent damage.

10.2.4.10 Check that manual release devices used to release agents require two separate and distinct actions for operation. They shall be properly identified. Particular care shall be taken where manual release devices for more than one system are in close proximity and could be confused or the wrong system actuated. Manual release devices in this instance shall be clearly identified as to which hazard enclosure they protect.

10.2.4.11 Check that for systems with a main/reserve capability, the main/reserve switch is properly installed, readily accessible and clearly identified.

10.2.4.12 Check that for systems using inhibit switches requiring constant manual force, these are properly installed, readily accessible within the hazard area and clearly identified.

10.2.4.13 Check that the control panel is properly installed and readily accessible.

10.2.5 *Preliminary Functional Tests*

10.2.5.1 Where a system is connected to a remote central alarm station, notify the station that the fire system test is to be conducted and that an emergency response by the fire department or alarm station personnel is not required. Notify all concerned personnel at the end-user's facility that a test is to be conducted and instruct them as to the sequence of operation.

10.2.5.2 Disable or remove each agent storage container release mechanism and directional valve, where fitted, so that activation of the release circuit will not release agent. Reconnect the release circuit with a functional device in lieu of each agent storage container release mechanism.

10.2.5.3 For electrically actuated release mechanisms, these devices may include suitable lamps, flash bulbs or circuit breakers. Pneumatically actuated release mechanisms may include pressure gauges, *see* IS 3624. Refer to the manufacturer's recommendations in all cases.

10.2.5.4 Check each resettable detector for proper response.

10.2.5.5 Check that polarity has been observed on all polarized alarm devices and auxiliary relays.

10.2.5.6 Check that all required end-of-line devices have been installed.

10.2.5.7 Check all supervised circuits for correct fault response.

10.2.6 *System Functional Operational Test*

10.2.6.1 Operate the detection initiating circuit(s). All alarm functions shall occur according to the design specification.

10.2.6.2 Operate the necessary circuit to initiate a second alarm circuit if present. Verify that all second alarm functions occur according to design specifications.

10.2.6.3 Operate the manual release device. Verify that manual release functions occur according to design specifications.

10.2.6.4 Where appropriate, operate the hold switch. Verify that functions occur according to the design specifications. Confirm that visual and audible supervisory signals are received at the control panel.

10.2.6.5 Check the function of all resettable valves and activators, unless testing the valve will release agent. 'One-shot' valves, such as those incorporating frangible discs, should not be tested.

10.2.7 *Remote Operations (if Applicable)*

10.2.7.1 Disconnect the primary power supply, then operate one of each type of input device while on standby power. Verify that an alarm signal is received at the remote panel after the device is operated. Reconnect the primary power supply.

10.2.7.2 Operate each type of alarm condition and verify receipt of fault condition at the remote station.

10.2.8 *Control Panel Primary Power Source*

10.2.8.1 Verify that the control panel is connected to a dedicated unswitched circuit and is labelled properly. This panel shall be readily accessible but access shall be restricted to authorized personnel only.

10.2.8.2 Test a primary power failure in accordance with the manufacturer's specification, with the system fully operated on standby power.

10.2.9 *Completion of Functional Tests*

When all functional tests are complete (*see* **10.2.5** to **10.2.8**), reconnect each storage container so that activation of the release circuit will release the agent. Return the system to its fully operational design condition. Notify the central alarm station and all concerned personnel at the end-user's facility that the fire system test is complete and that the system has been returned to full service condition by following the procedures specified in the manufacturer's specifications.

10.2.10 The complete installation shall be tested in one of the two methods narrated below:

a) Full-scale discharge test, and
b) Enclosure integrity test.

Where the authorities concerned insist on full-scale discharge test, the test shall be conducted in accordance with various provisions under Annex C and results of the test (that is concentration achieved, discharge time, holding time) shall conform to various provisions available in other clean agent standards with particular reference to the agent used. Otherwise, the enclosure where total flooding system is installed, shall be subject to 'enclosure integrity test' to demonstrate the retention time (of the required concentration with the enclosure) as specified in other standards with particular reference to the agent used.

10.3 Completion Certificate and Documentation

The installer shall provide to the user a completion certificate, a complete set of instructions, calculations and drawings showing the system as-installed, and a statement that the system complies with all the appropriate requirements of this standard and giving details of any departure from appropriate recommendations. The certificate shall give the design concentrations and, if carried out, reports of any additional test including the door fan test.

11 SYSTEM HYDRAULIC FLOW CALCULATIONS

11.1 General

System flow calculations shall be carried out at a nominal agent storage temperature of 20 °C, shall have been validated by an accredited approval authority by appropriate tests as described in this part of standard, and shall be properly identified. The system design shall be within the manufacturer's specified limitations.

NOTES

1 Variations from the nominal 20 °C storage temperature will affect flow conditions used in calculations.

2 Pre-engineered systems do not require a flow calculation when used within approved limitations.

11.2 Balanced and Unbalanced System

11.2.1 A balanced system (*see* Fig. 1) shall be one in which,

a) each actual or equivalent pipe length from the container to each nozzle are all within 10 percent of each other; and
b) the discharge rate of each nozzle is equal.

11.2.2 Any system that does not meet the criteria mentioned in **11.2.1** shall be considered to be an unbalanced system (*see* Fig. 2).

11.3 Friction Losses

Allowance shall be made for the friction losses in pipes and in container valves, dip tubes, flexible connectors, selector valves, time delay devices and other equipment (for example, pressure-reducing devices) within the flow line.

NOTE — The flow of a liquefied gas will be a two-phase phenomenon, the fluid consisting of a mixture of liquid and vapour, the proportions of which are dependent on pressure and temperature. The pressure drop is non-linear, with an increasing rate of pressure loss as the line pressure reduces by pipe friction.

11.4 Pressure Drop

The pressure drop shall be calculated using two phase flow equations for liquefied gases and single-phase flow equations for non-liquefied gases. *See* Annex D.

NOTE — These equations use friction factors and constants dependent on pressure and density obtained empirically. As the equations cannot be solved directly, a computer programme is usually used to assist with the large number of iterative calculations in which pipe and nozzle sizes and if appropriate, size of pressure reducing devices, are selected within prescribed pressure losses.

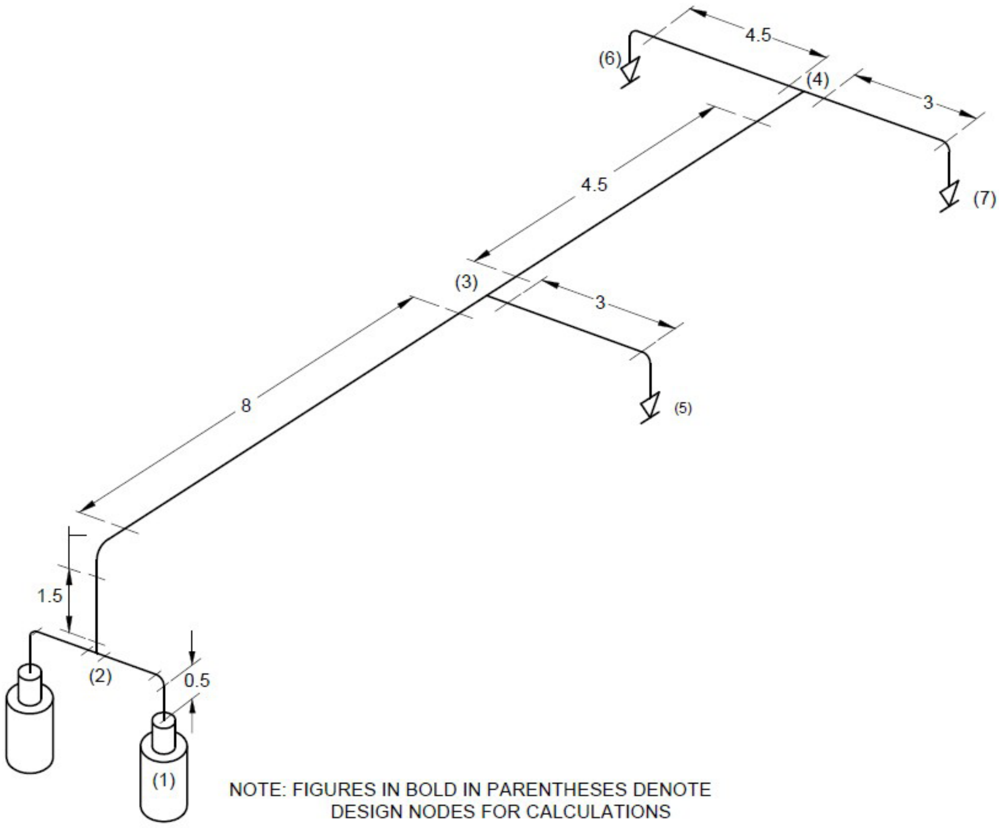

4.5
(6)
(4)
3
(7)
4.5
(3)
3
(5)
8
1.5
(2)
0.5
(1)
NOTE: FIGURES IN BOLD IN PARENTHESES DENOTE DESIGN NODES FOR CALCULATIONS

FIG. 2 TYPICAL UNBALANCED SYSTEM

11.5 Valves and Fitting

Valves and fittings shall be rated for resistance coefficient or equivalent length in terms of pipe, or tubing sizes with which they will be used. The equivalent length of the cylinder valves shall be listed and shall include siphon tube (where fitted), valve, discharge head and flexible connector.

11.6 Piping Length

The piping length and nozzle and fitting orientation shall be in accordance with the manufacturer's approved manual to ensure proper system performance.

11.7 Drawings

If the final installation varies from the prepared drawings and calculations new 'as-built' drawings and calculations shall be prepared.

11.8 Liquefied Gases — Specific Requirements

11.8.1 Allowance shall be made for changes in elevation as specified in the relevant of standard relating to the specific agent.

11.8.2 Minimum discharge rate for liquefied agents shall be sufficient to maintain the velocity required for turbulent flow to prevent separation.

NOTE — If turbulent flow is not maintained, separation of the liquid and gaseous phases will occur, which can lead to unpredictable flow characteristics.

12 MONITORING OF GAS EXTINGUISHING SYSTEMS

12.1 General

12.1.1 Halocarbon gas extinguishing systems shall be automatically monitored for their availability in the case of,

a) systems with more than 500 m^3 of protected volume, and
b) systems with more than 250 m^3 of protected volume where a delay time is required for life safety aspects.

12.1.2 The following components indicted in **12.2** to **12.10** shall be monitored continuously for their availability and faults (that is cases of non-availability) shall be automatically indicated. Their failure or a wrong operating position can prevent the emission of the (correct amount of) extinguishing medium or the functioning of the alarm and delay device in case of triggering, or it can cause an emission into an untriggered extinguishing zone.

12.1.3 Testing of the monitoring system shall always be always in service.

12.1.4 The monitoring system shall not affect the correct function of the gas extinguishing system.

12.2 Disable and Triggering Devices and Selector Valves

The correct operating position of the following components shall be monitored:

a) Non-electrical control devices.
b) Disable devices.
c) Directional valves.
d) Switch devices for main/reserve supply container.
e) In the case of mechanical control using wire cables-the position of the triggering device.

12.3 Agent Quantity Measurement

The quantity of available extinguishant and pilot gas shall be monitored. Any loss of more than 10 percent of the content of any container shall be indicated. Also,

a) all containers of the main supply and of the reserve supply permanently connected to the pipe system, and
b) containers for the supply of the alarm devices and/or pilot containers.

12.4 Electrical Lines

12.4.1 Electrical lines transmitting alarm and fault signals or signals for the monitoring and control of the installation and alarm devices (monitored first alarm with two independent energy supplies) shall be monitored for line break, short circuit and earth fault. System shall be cross-checked with IS 2189 and IS 15908.

12.4.2 Necessary additional controlling signals (for example, shut-off of ventilation systems, closing of openings of the enclosure) may be transmitted by non-monitored lines.

12.5 Electrically Operated Components

The power supply to electrically-operated components of the extinguishing installation shall be monitored for normal condition and power failure where they cannot be monitored by the fire detection installation.

12.6 Monitoring and Control Lines

12.6.1 *Monitoring Lines*

Each monitoring device shall have a separate indicator. A maximum of 60 monitoring devices may be connected to one detection line.

12.6.2 *Monitoring Lines of Disable Devices*

a) Faults of the disable device shall be indicated if the disable device is in a position that is neither the ready-for service-position (open) nor the blocking position (closed) (*see* **12.2**).
b) Independent from that, the actuation of the disable device shall be transmitted and indicated separately.
c) The disabled condition of the system shall not cause a general fault indication but the disabled condition of the system shall be indicated separately for each flooding zone.

12.6.3 *Control Lines*

a) All electrically controlled components for the release of the installation, operation of selector valves, delay devices and alarm devices shall be connected to lines monitored for line break, short circuit and earth fault.
b) The devices shall be attached to the control lines so that in the case of a fault indication an unequivocal and quick identification of the components of the installation causing this fault indication is possible.
c) This is relevant for,
    1) triggering devices of pilot containers, container batteries, isolating valves and selector valves, or
    2) electromagnetic locking devices for triggering devices and/or selector valves and solenoid valves for controlling the emergency-stop device and/or secondary flooding function.

12.7 Storage Area

The storage area shall be monitored for the allowable maximum and minimum ambient temperature where a dedicated heating or cooling system is installed.

12.8 Fault Indication

12.8.1 *Indication and Transmission*

Faults of the extinguishing installation shall be indicated visually and audibly at a location of the premises, which is continuously manned. It shall be possible to switch off the audible signal, but the visual signal shall only be switched off if the fault is removed. If the plant does not dispose of a continuously manned location, the fault indication shall be transmitted automatically to an employee of the plant (for example, by the help of a telephone transmitter).

12.8.2 *Further Indications*

a) The fault indication of the following shall be indicated separately by,
    1) monitoring system of the gas extinguishing system,
    2) other monitoring systems,
    3) fire detection system, and
    4) control devices.

b) Faults of the extinguishing installation and faults of the monitoring installation shall be indicated separately.

NOTE — As long as a fire detection signal of the extinguishing installation is present, no fault detection shall be indicated at the monitoring control panel.

12.9 Power Supply of the Monitoring Installation

The power supply of the monitoring installation shall comply with IS 2189 and IS 15908 in all respects.

12.10 Requirements for Components of the Monitoring Installation

12.10.1 *Protection Class*

The components of the monitoring installation shall fulfil at least the protection class IP 54.

12.10.2 *Switching Way*

In case of valves, the fault indications shall depend on the switching way of the component under monitoring. The switching way is the way from the just still closed to the totally opened position of the valve.

12.10.3 *Switching Way of Normally Open Devices*

The fault indication for valves which are situated in the extinguishant flow and in the pneumatic pilot lines, and the fault indication for other blocking devices which are continuously opened when the extinguishing installation is ready for service, shall be activated at the latest, when the components are closed 20 percent of the switching way.

12.10.4 *Switching Way of Normally Closed Devices*

In case of valves in the extinguishant flow and in case of valves which are not situated directly in the extinguishant flow and which are closed when the extinguishing installation is ready for service, the fault indication shall be activated immediately when the opening procedure starts.

12.10.5 *Blocking Devices of Alarm Devices, Pressure or Pneumatic Switches*

In case of blocking devices of alarm devices and pressure or pneumatic switches, the fault indication shall be effective already in intermediate positions.

12.10.6 *Non-electrical Control Devices*

a) Non-electrical control devices shall be monitored. The requirement is fulfilled if the room with the non-electrical control device is only accessible to authorized persons and if opening the door causes a fault indication.
b) Components may not be monitored if they are automatically reset into their operating position by the triggering energy of the installation itself.

13 REGULAR INSPECTION EXERCISE

13.1 Regular inspections shall be carried out to ensure that the system functions properly. The frequency and type of inspections shall depend on the nature of the installation, national legislation and environment, etc.

13.2 Inspections shall be made by personnel specially designated for this work, thoroughly instructed in their duties, with a comprehensive knowledge of the installation. Daily, weekly and monthly inspections shall be carried out according to the manufacturer’s specifications.

13.3 Daily Inspection

Check all installation indications visually.

13.4 Weekly Inspection

a) Check fire detection system.
b) Check quantity of gas, replacing or topping-up if a loss of weight or pressure in excess of 10 percent has occurred.
c) Check operational position of valves.
d) Check power supplies.

13.5 Monthly Inspection

a) Check equipment used to actuate fire doors and hatches and power supplies, etc.
b) Check audible and visual alarm devices.
c) Check delay device.
d) Check nozzles (visual test).
e) Check enclosure (visual test).
f) Check ancillary equipment.

13.6 Details of observation during the routine inspection shall be logged in a register.

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
732 : 2019	Code of practice for electrical wiring installations (*fourth revision*)
1239	Steel tubes, tubulars and other wrought steel fittings — Specification
(Part 2) : 2011	Part 2 Steel pipe fittings (*fifth revision*)
2189 : 2008	Selection, installation and maintenance of automatic fire detection and alarm system — Code of practice (*fourth revision*)
3624 : 1987	Pressure and vacuum gauges (*second revision*)
6631 : 1972	Steel Pipes for Hydraulic Purposes
7673 : 2004	Glossary of terms for firefighting equipment (*first revision*)
8757 : 1999	Glossary of terms associated with fire safety (*first revision*)
15496 : 2004	Inspection and maintenance of gaseous fire extinguishing systems — Code of practice
15497 : 2004	Gaseous fire extinguishing systems IG 01 extinguishing systems
15501 : 2004	Gaseous fire extinguishing systems IG 541 extinguishing systems
15505 : 2004	Gaseous fire extinguishing systems — HCFC Blend A extinguishing systems
15506 : 2004	Gaseous fire extinguishing systems — IG 55 extinguishing systems
15517 : 2004	Gaseous fire extinguishing systems — HFC 227ea (Hepta Fluoro Propane) extinguishing systems
15525 : 2004	Gaseous fire extinguishing systems — IG 100 extinguishing systems
15528 : 2004	Gaseous fire extinguishing systems — Carbon dioxide total flooding and local application (Sub-floor and in-cabinet), high and low pressure (refrigerated) systems
15821 : 2008	Gaseous fire extinguishing system — Physical properties and system design — CF4I Extinguishant
15835 : 2009	Gaseous fire extinguishing systems HFC — 125 Extinguishing systems
15908 : 2021	Selection, installation and maintenance of control and indicating equipment for fire detection and alarm system — Code of practice (*first revision*)
SP 30 : 2011	National Electrical Code (*first revision*)

ANNEX B

[*Clause* 6.1.2 (a)]

INFORMATION ON SAFETY TO PERSONNEL AND DECOMPOSITION PRODUCTS OF COMBUSTION

B-1 Any hazard to personnel created by the discharge of gaseous extinguishants shall be considered in the design of the system, in particular with reference to the hazards associated with particular extinguishants in the other standards of clean agents. Unnecessary exposure to all gaseous extinguishants shall be avoided.

B-2 The decomposition products generated by the clean agent breaking down in the presence of very high amounts of heat can be hazardous. All of the present halocarbon agents contain fluorine. In the presence of available hydrogen (from water vapour, or the combustion process itself), the main decomposition product is hydrogen fluoride (HF).

B-3 These decomposition products have a sharp, acrid odour, even in minute concentrations of only a few parts per million. This characteristic provides a built-in warning system for the agent, but at the same time creates a noxious, irritating atmosphere for those who must enter the hazard following a fire.

B-4 The amount of agent that can be expected to decompose in extinguishing a fire depends to a large extent on the size of the fire, the particular clean agent, the concentration of the agent, and the length of time the agent is in contact with the flame or heated surface. If there is a very rapid build-up of concentration to the critical value, then the fire will be extinguished quickly and the decomposition will be limited to the minimum possible with that agent. Should that agent's specific composition be such that it could generate large quantities of decomposition products, and the time to achieve the critical value is lengthy, then the quantity of decomposition products can be quite great. The actual concentration of the decomposition products then depends on the volume of the room in which the fire was burning and on the degree of mixing and ventilation.

B-5 Although the vapour from halocarbon gas has low toxicity, the decomposition products can be very hazardous. The most widely accepted theory is that the vapour must decompose before the agent can inhibit the combustion reaction. Decomposition takes place on exposure to a flame or to a hot surface at a temperature above 480 °C. In the presence of available hydrogen (from water vapour or the combustion process itself), the main decomposition product is hydrogen fluoride (HF).

B-6 The decomposition products of halocarbon agents have a characteristic sharp acrid odour, even in minute concentrations of only a few parts per million. This characteristic provides a built-in warning system for the extinguishant, but at the same time creates a noxious, irritating atmosphere for those who have to enter the enclosure following a fire. The actual concentration of the decomposition products depends on the volume of the enclosure in which fire is burning and the degree of mixing and ventilation.

B-7 Longer exposure of the vapour to temperatures in excess of 482 °C would produce greater concentrations of these gases. The type and sensitivity of detection, coupled with the rate of discharge, should be selected to minimize the exposure time of the vapours to the elevated temperature if the concentration of breakdown products is to be minimized. In most cases, the area would be untenable for human occupancy due to the heat and breakdown products of the fire itself.

B-8 Clearly, longer exposure of the agent to high temperatures would produce greater concentrations of these gases. The type and sensitivity of detection, coupled with the rate of discharge, should be selected to minimize the exposure time of the agent to the elevated temperature if the concentration of the breakdown products is to be minimized.

B-9 Non-liquefied agents do not decompose measurably in extinguishing a fire. As such, toxic or corrosive decomposition products are not found. However, breakdown products of the fire like carbon monoxide itself can still be substantial and could make the area untenable for human occupancy.

ANNEX C

(*Clause* 10.2.10)

REQUIREMENTS FOR FULL-SCALE DISCHARGE TEST

C-1 This clause sets out a procedure to determine compliance of the gaseous total flooding system with the requirements for discharge time, concentration and holding time.

C-2 PRINCIPLE

The system is operated, discharge time is measured and concentration readings are taken at a specified height at nominated periods.

C-3 TEST MEDIUM

The test medium shall be the concerned halocarbon or inert gas.

C-4 APPARATUS

The following apparatus are required:

a) A chart recorder type concentration meter calibrated in strict accordance with the manufacturer's instructions,

b) A suitable time-measuring device, and

c) Temperature-measuring equipment.

C-5 PROCEDURE

The procedure shall be as follows:

a) Ensure that the preliminary checks in accordance with respective standard pertaining to gaseous fire extinguishing system have been completed.

b) Electrically isolate all flooding systems serving adjacent enclosures.

c) Concentration measurements should be made at a minimum of three points, one at the highest hazard level.

d) Locate sampling points in the enclosure at the specified heights.

e) Do not locate sampling points nearer than 200 mm to ceiling unless the combustibles being protected extend within that area, in which case special design considerations may be necessary.

f) If more than one space or compartment is being simultaneously protected, locate a sampling point in each space in accordance with the above criteria. Additional sampling points may be required by the appropriate authority.

g) Where the geometry of the enclosure does not lend itself to sampling in the above manner, take a minimum of three samples at locations agreed upon by the appropriate authority.

h) Set the continuous chart recorder type concentration meter for the agent concerned and check that the meter is calibrated in accordance with the manufacturer 's instructions so that it will record concentration levels at each sampling point for 10 min from commencement of discharge.

j) Record temperature in enclosure.

k) Ensure that plant which is capable of affecting system performance, for example, air-handling plant is in its normal operating mode.

m) Activate the system and record the discharge time.

n) Record concentration readings and holding times.

C-6 RECOMMISSIONING

Restore all systems to a fully operational status.

C-7 REPORTING

The following shall be reported:

a) Details of,
    1) installation, designer and contractor;
    2) enclosure identification;
    3) enclosure temperature prior to discharge;
    4) design concentration; and
    5) position of sampling points.

b) Date and time of test.

c) Discharge time.

d) Concentrations at each sampling point at 1 and 10 min from the commencement of discharge.

e) System deficiencies.

Cross-check various observed parameters with the respective operating clauses are in conformity therewith.

ANNEX D

(*Clause* 11.4)

INFORMATION ON TWO-PHASE FLOW FOR LIQUEFIED HALOCARBON GASES

D-1 As the extinguishant in the liquid phase flows from the storage container, the pressure drops or recedes. The pressure recession varies with container fill density. It is assumed that there was thermodynamic equilibrium between the liquid and vapour phases in the storage container. In actual tests, it has been noted that there is a sharp drop in pressure during the initial rush of liquid into the distribution system. This is due to a lag between the pressure drop and the onset of boiling in the container. As boiling commences, the pressure returns to the pressures shown on the curves for respective gaseous extinguishants representing the calculated pressure in the storage container versus the percentage discharge of extinguishant from the container for both 2.5 MPa and 4.2 MPa systems.

D-2 AGENT IN PIPE WORK

Agent flows through the distribution system in both liquid and vapour phase. As the liquid phase flows through the distribution system the pressure continues to drop, causing the liquid to boil. The volume of the vapour phase increases with the decreasing pressure and hence the density of the mixture drops. To maintain a constant flow rate, the speed through the distribution system must continuously increase down the pipe work. The pressure drop for a given flow rate is not linear, as it is with water, but is variable along the pipe.

D-3 DENSITY OF AGENT IN DISTRIBUTION SYSTEM

Using the thermodynamic properties of the agent including the nitrogen used for super-pressurization, the density of the two-phase mixture in the distribution system can be calculated. The density of the agent leaving the storage container varies over the course of the discharge. The density is lowest at the start of discharge and increases until the last of the liquid leaves the container.

D-4 TEMPERATURE

The drop-in container pressure as the agent flows from the container causes remaining agent in the container to cool. As a result, liquid that is below ambient temperature is introduced to the distribution system. During a system discharge the temperature of the agent leaving the storage container recedes as a function of instantaneous container pressure.

D-5 INITIAL VAPOUR TIME

At the start of discharge, virtually all the liquid phase of the agent entering the distribution system is vaporized before it reaches the nozzles, due to heating by the pipe work and the initial low pressure in the system. The initial vapourization limits the flow of agent through the distribution system because the mass flow of vapour is much lower than that of liquid.

D-6 LIQUID FLOW

There is a significant delay between the opening of the discharge valve and the first appearance of liquid at the nozzles. Some of the delay is due to the flow restriction presented by the container and distribution system, however, much of delay is due to the initial vapour phase flow of the agent.

D-7 PHASE SEPARATION

The flow of agent in the distribution system is a two-phase flow (containing both liquid and vapour). In a properly sized distribution system the flow will be highly turbulent throughout the system and the two phases will mix homogeneously. If the pipes are too big the phases may tend to separate, which can cause a variety of flow problems and can in some cases result in a reduced flow rate.

D-8 AVERAGE PRESSURE CONDITIONS

Pressure at the nozzle is not constant throughout discharge because the pressure in the storage container is constantly decreasing. If one were to attempt manual calculation it would be desirable to use an average pressure condition. It is difficult to arrive at an average as the volume of piping has a marked effect on the average nozzle (pressure, density and velocity conditions), all of which, have a marked effect on discharge quantities and times.

D-9 AVERAGE NOZZLE PRESSURE

The nozzle pressure used for calculations is the pressure when half the liquid phase has been discharged from the nozzle. The timing of this is used to calculate an average pressure drop in the distribution system. To calculate the correct storage container pressure, allowance must be made for the amount of liquid in the piping system.

D-10 PERCENT IN DISTRIBUTION SYSTEM

The points outlined above are taken into consideration to calculate the average container pressure during discharge. The ratio of the pipe volume to the volume of agent supply expanded under flowing conditions varies with average container pressure. The former quantity shall be referred to as percent-in-the-pipe.

ANNEX E

(*Foreword*)

COMMITTEE COMPOSITION

Fire Fighting Sectional Committee, CED 22

Organization	*Representative(s)*
Ministry of Home Affairs, New Delhi	Shri D. K. Shami (***Chairman***)
Agni Controls, Chennai	Shri D. Balachandran Shri Arun Kumar Balachandran (*Alternate*)
Airports Authority of India, New Delhi	Shri Subhash Kumar Shri P. K. Deshmukh (*Alternate*)
Bhabha Atomic Research Centre, Mumbai	Chief Fire Officer
CSIR-Central Building Research Institute, Roorkee	Dr R. S. Chimote Shri Suvir Singh (*Alternate*)
Central Industrial Security Force, New Delhi	Shri Rajnath Singh Shri A. K. Verma (*Alternate*)
Central Public Works Department, New Delhi	Shri Chaitanya Kumar Verma Shri D. K. Tulani (*Alternate*)
Centre for Fire & Explosive Environment Safety (DRDO), Ministry of Defence, Delhi	Shri M. K. Jain Shri Amit Saini (*Alternate*)
Chennai Petroleum Corporation Ltd, Chennai	Shri J. P. K. Hepat
Chhatariya Rubber & Chemicals Industries, Mumbai	Shri S. A. Haveliwala Shri H. S. Haveliwala (*Alternate*)
City and Industrial Development Corporation	Shri Arvind P. Mandke
Directorate General of Quality Assurance, Ministry of Defence, Pune	Controller QA (FE) Joint Controller QA (FE) (*Alternate*)
Delhi Fire Services, New Delhi	Director Chief Fire Officer (*Alternate*)
Directorate of Fire and Emergency Services, Panaji	Shri Ashok Menon Shri Nitin V. Raiker (*Alternate*)
Engineers India Ltd, New Delhi	Shri R. B. Bhutda Shri Vipan Goel (*Alternate*)
F. M. Engineering International India Branch, Bengaluru	Shri Srikanth Yajjala Shri Manikandan Krishnamoorthy (*Alternate*)
Fire & Emergency Services, J&K, Srinagar	Shri V. K. Singh Shri Bashir Ahmed Shah (*Alternate*)
Fire & Security Association of India, Chennai	Shri Anas Rizwi
Fire Protection Association of India, Mumbai	President
GAIL (India) Limited, New Delhi	Shri S. P. Garg Shri Sanjeev Kumar Kalkal (*Alternate*)
Gunnebo India Pvt Limited, Thane	Shri Ashutosh Satpute Shri Gajanan Medewar (*Alternate*)
H. D. Fire protect Pvt Limited, Thane	Shri Harish N. Dharamshi Shri K. T. Chaudhari (*Alternate*)
Indian Oil Corporation Limited, Noida	Shri Aashish R. Gokhale

Organization	*Representative(s)*
Institution of Fire Engineers (India), New Delhi	President General Secretary (*Alternate*)
Johnson Controls (India) Pvt Ltd, Gurugram	Shri Santosh Muzumdar Shri Nitin Rastogi (*Alternate*)
K. V. Fire Chemicals (India) Pvt Ltd, Navi Mumbai	Shri Rajesh H. Sabadra Shri Uday K. Shroff (*Alternate*)
Karnataka State Fire and Emergency Services, Bengaluru	Shri K. U. Ramesh Shri K. Srinivasa (*Alternate*)
Maharashtra Fire Services, Mumbai	Shri S. S. Warick
Military Engineer Services, Engineer-in-Chief's Branch, Integrated HQ MoD (Army), New Delhi	Shri Sanjay Sharma Shri A. K. Dubey (*Alternate*)
Mumbai Fire Brigade, Mumbai	Shri P. S. Rahangdale Shri H. D. Parab (*Alternate*)
National Association of Fire Officers, Mumbai	President
NBCC (India) Ltd, New Delhi	Shrimati Sunita Purswani Shri R. K. Agarwal (*Alternate*)
Nohmi Bosai (India) Pvt Ltd, Gurugram	Shri Ishwar Iyer Shri Ajit Raghavan (*Alternate*)
Oil Industry Safety Directorate, New Delhi	Shri S. K. Nandy
Reliance Industries Limited, Mumbai	Shri Varadendra Koti Shri Umesh Khandalkar (*Alternate*)
RESQ Technologies, Ahmedabad	Shri Rohit V. Shah
Safex Fire Services Limited, Mumbai	Shri Jitendra Shah Shri Sandip Shah (*Alternate*)
Shah Bhogilal Jethalal & Bros, Ahmedabad	Shri Mukesh M. Shah Shri Abhay D. Purandare (*Alternate*)
State Bank of India, Mumbai	Shri Vinayak Gokhale
Surex Production and Sales Private Limited, Kolkata	Shri Debashis Neogi
Swastik Synergy Engineering Pvt Ltd, Mumbai	Shri Mukesh D. Shah Shri Kunal Zatakia (*Alternate*)
Tamil Nadu Fire and Rescue Services Department, Chennai	Shri S. Vijayasekar Shrimati N. Priya (*Alternate*)
The Supreme Industries Ltd, Mumbai	Shri Kisan Kundalkar Shri G. K. Saxena (*Alternate*)
UL India Pvt Limited, Bengaluru	Shri Suresh Shanmugam Shri S. P. Tej Kumar Behara (*Alternate*)
Uttar Pradesh Fire Services, Lucknow	Shri P. K. Rao Shri Aman Sharma (*Alternate*)
West Bengal Fire and Emergency Service, Kolkata	Shri Abhijit Pandey Shri Kamal Nandy (*Alternate*)
In personal capacity (*B-152, Ist Floor, East of Kailash, New Delhi*)	Shri Hemant Kumar
In personal capacity (K-*33-A, Green Park, New Delhi*)	Shri S. K. Dheri
In personal capacity (*A-45, Sector-70, Noida*)	Dr H. S. Kaprwan

Organization	*Representative(s)*
In personal capacity (*D-317, 2nd Floor, Nirman Vihar, New Delhi*)	Shri R. C. Sharma
In personal capacity (*27A, Tapovan Senior Citizens Foundation, Coimbatore 641 010*)	Shri T. R. A. Krishnan
BIS Directorate General	Shri Sanjay Pant, Scientist 'F' and Head (Civil Engineering) [Representing Director General (*Ex-officio*)]

Member Secretary

Shri S. Arun Kumar
Scientist 'E' (Civil Engineering), BIS

Fire Detection Alarms and Suppression System Subcommittee, CED 22 : 4

Organization	*Representative(s)*
Ministry of Home Affairs, New Delhi	Shri D. K. Shami (***Convener***)
Agni Controls, Chennai	Shri D. Balachandran Shri Selvakumar Balachandran (*Alternate*)
ASTRAL Polytechnik Ltd, Ahmedabad	Shri Ritesh Patel Shri Manoj Dhar (*Alternate*)
Bhabha Atomic Research Centre, Mumbai	Chief Fire Officer
CSIR-Central Building Research Institute, Roorkee	Shri Rajiv Goel Shri R. S. Chimote (*Alternate*)
Central Public Works Department, New Delhi	Shri Chaitanya Kumar Verma Shri D. K. Tulani (*Alternate*)
Central for Fire Explosive Environment Safety (DRDO), (Ministry of Defence) Delhi	Shri M. K. Jain Shri Amit Saini (*Alternate*)
Chennai Petroleum Corporation Limited, Chennai	Shri J. P. K. Hepat
Directorate General of Quality Assurance, Ministry of Defence, Pune	Col V. V. Kadam Col N. K. N. Rao (*Alternate*)
Delhi Fire Service, New Delhi	Director Chief Fire Officer (*Alternate*)
DSPA Fire Suppressions India Pvt Ltd, Pune KNOTEK	Shri Chetan Udgir
EAST Corp, Thane	Shri Hemant Khadse
Engineers India Ltd, New Delhi	Shri Vipan Goel Shri R. B. Bhutda (*Alternate*)
FOGTEC Brandschutz GmbH & Co KG, Mumbai	Shri Jackson Jose
F. M. Engineering International India Branch, Bengaluru	Shri Srikanth Yajjala Shri Manikandan Krishnamoorthy (*Alternate*)
FYRPROTEK (Fire Engineers & Consultants), New Delhi	Shri Gulshan Khurana
Gunnebo India Pvt Limited, Thane	Shri Ashutosh Satpute Shri Gajanan Medewar (*Alternate*)

Organization	*Representative(s)*
Honeywell International (I) Pvt Ltd, Bengaluru	Shri Mandar Sawant Shri Akhand Kumar (*Alternate*)
Institution of Fire Engineers (India) Ltd, New Delhi	President General Secretary (*Alternate*)
Johnson Controls (India) Private Limited, Gurugram	Shri Santosh Muzumdar Shri Ashish Dileep Sawant (*Alternate*)
Maple Engineering Design Services (India), Pvt Ltd, Bengaluru	Shri B. S. A. Narayan Shri H. R. Rangannath (*Alternate*)
Municipal Corporation of Greater Mumbai, Mumbai	Chief Fire Officer Deputy Fire Officer (*Alternate*)
Newage Industries, Mumbai	Shri Ashok M. Shah Shri Shetul A Shah (*Alternate*)
Nitin Fire Protection Industries Ltd, Mumbai	Shri Nitin M. Shah Shri Pravin Shah (*Alternate*)
Nohmi Bosai (India) Pvt Ltd, Gurugram	Shri Ajit Raghavan
Proion Consultants, New Delhi	Shri Sandeep Goel
Realty Automation and Security Systems Pvt Ltd, Pune	Shri Anant Gokhale
Reliance Industries Limited, Mumbai	Shri Varadendra Koti Shri Umesh Khandalkar (*Alternate*)
Saviram Engineering Consultants Pvt Ltd, Noida	Shri Girish Mishra
SCHRACK SECONET AG, Gurugram	Shri Ajit Saini
Steel Authority of India Ltd, Salem	Shri D. Kumaresan
The Supreme Industries Ltd, Mumbai	Shri Kisan Kundalkar Shri G. K. Saxena (*Alternate*)
West Bengal Fire and Emergency Service, Kolkata	Representative
In personal capacity (*A-45, Sector-70, Noida*)	Dr H. S. Kaprwan
In personal capacity (*D-317, 2nd Floor, Nirman Vihar, New Delhi*)	Shri R. C. Sharma
In personal capacity (*27A, Tapovan Senior Citizens Foundation, Coimbatore 641 010*)	Shri T. R. A. Krishnan
In personal capacity (*K-33-A, Green Park, New Delhi*)	Shri S. K. Dheri
In personal capacity, New Delhi	Shri Kanwar A. Singh

(*Continued from second cover*)

Nothing in this standard is intended to restrict new technologies or alternate arrangements provided the level of safety prescribed by this standard is not diluted.

In the formulation of this standard, assistance has also been derived from ISO 14520-1 : 2015 ‘Gaseous fire-extinguishing systems — Physical properties and system design — Part 1: General requirements’.

The composition of the Committee responsible for the formulation of this standard is given in Annex E.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 ‘Rules for rounding off numerical values (*revised*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act*, 2016 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Copyright

BIS has the copyright of all its publications. No part of these publications may be reproduced in any form without the prior permission in writing of BIS. This does not preclude the free use, in the course of implementing the standard, of necessary details, such as symbols and sizes, type or grade designations. Enquiries relating to copyright be addressed to the Director (Publications), BIS.

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards: Monthly Additions'.

This Indian Standard has been developed from Doc No.: CED 22 (14674).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones: 2323 0131, 2323 3375, 2323 9402 *Website*: www.bis.gov.in

Regional Offices: *Telephones*

Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg
NEW DELHI 110002 — 2323 7617, 2323 3841

Eastern : 1/14 C.I.T. Scheme VII M, V.I.P. Road, Kankurgachi
KOLKATA 700054 — 2337 8499, 2337 8561, 2337 8626, 2337 9120

Northern : Plot No. 4-A, Sector 27-B, Madhya Marg
CHANDIGARH 160019 — 265 0206, 265 0290

Southern : C.I.T. Campus, IV Cross Road, CHENNAI 600113 — 2254 1216, 2254 1442, 2254 2519, 2254 2315

Western : Manakalaya, E9 MIDC, Marol, Andheri (East)
MUMBAI 400093 — 2832 9295, 2832 7858, 2832 7891, 2832 7892

Branches : AHMEDABAD. BENGALURU. BHOPAL. BHUBANESHWAR. COIMBATORE. DEHRADUN. DURGAPUR. FARIDABAD. GHAZIABAD. GUWAHATI. HYDERABAD. JAIPUR. JAMMU. JAMSHEDPUR. KOCHI. LUCKNOW. NAGPUR. PARWANOO. PATNA. PUNE. RAIPUR. RAJKOT. VISAKHAPATNAM.

Published by BIS, New Delhi